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VOLUME XXXV, 1942

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'26. Cartwright, O. L., Agri. Exp. Station, Clemson College, Clemson College, S. C. (F. '41). *Scarabaeidae.*
'26. Cartwright, William B., Box 495, Lafayette, Indiana. *Hessian Fly.*
'29. Cecil, R., P. O. Box 1330, Ventura, California. *Bean Insects.*
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'22. Chamberlin, Joseph C., P. O. Box 278, Forest Grove, Oregon. (F. '38). *Chelonethida.*
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'15. Chapman, James W., Silliman Inst., Dumaguete, Philippine Is. *Ants of P. I.*
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'25. Deay, Howard O., Dept. Ent., Purdue Univ., Lafayette, Ind. *Coreidae, Tenagobia, Micronecta.*

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'38. Emerson, K. C., Ft. William McKinley, Rizal, Philippine Islands. *Mallophaga.*
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'31. Fletcher, Fred W., Biochem. Dept., Dow Chemical Co., Midland, Michigan. *Insecticides.*
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'38. Hathaway, Edward S., Dept. of Zool., Tulane Univ., New Orleans, La. *Ecology of Marsh Insects.*
'32. Haub, James G., Dept. of Zool., Ohio State University, Columbus, Ohio. *Physiology.*
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'08. HILTON, WM. A., 1263 Dartmouth Ave., Claremont, Calif. (F. '39). *Symphyla, Pauropoda.*
'27. HINMAN, E. HAROLD, Health & Safety Dept., Tennessee Valley Authority, Wilson Dam, Alabama. (F. '37). *Culicidae.*
'33. Hinton, Howard E., Dept. of Zool., Univ. of Cambridge, Downing St., Cambridge, England. *Dryopidae.*
'34. Hitchcock, John David, Intermountain Bee Culture Field Laboratory, Laramie, Wyo. *Bacteriology of Bee Diseases.*
'38. Hitchcock, O. B., 816 W. Kack, Bozeman, Mont. *Mormon Cricket.*
'27. Hockenyos, Geo. L., 213 E. Jefferson St., Springfield, Ill. *Economic Entomology.*
'38. Hodge, Charles 4th Dept. of Biology, Temple Univ., Philadelphia, Pa. *Coleoptera.*
Ch. Hodgkiss, H. E., Exp. Sta. Bldg., State College, Pa. *Eriophyiidae.*
'29. Hodson, A. C., Div. Entomology, Univ. Farm, St. Paul, Minn. *Ecology.*
'14. *HOFFMAN, W. A., Sch. Trop. Med., San Juan, Porto Rico. (F. '40). *Biting Flies.*
'39. Hoffman, Carlos C., Apartado 8026, Mexico D. F., Mexico. *Medical Entomology and Lepidoptera.*
'29. Hoffman, Clarence H., 157 Tacoma Circle, Asheville, N. C. *Scarabaeidae.*
'20. HOFFMAN, WM. E., Lingnan Univ., Canton, China. (F. '39). *Hemiptera.*
'35. Holway, Richard T., South Duxbury, Mass. *Termites.*
Ch. HOOD, J. DOUGLAS, Dept. Entomology, Cornell Univ., Ithaca, N. Y. (F. '32). *Thysanoptera.*
'38. Hoogstraal, Harry, 303 Entomology Bldg., Univ. of Illinois, Urbana, Ill. *Morphology.*
'34. Horsfall, William R., 20 South Duncan, Fayetteville, Arkansas. *Culicidae.*
'34. Hoskins, W. M., 112 Agri. Hall, Univ. of Calif., Berkeley, Calif. *Physiology.*
'24. Hough, W. S., Winchester, Virginia. *Apple Insects.*
Ch. HOUSER, J. S., Agri. Exp. Sta., Wooster, Ohio. (F. '31). *Coccidae.*
'39. Hovey, Charles L., Aroostook Farm, Presque Isle, Maine. *Aphiidae.*
Ch. HOWARD, L. O., Bur. Ent. & P. Q., Washington, D. C. (F. '07, H. F. '24). *Chalcidoidea.*

'14. Howard, Neale F., 151 West 11th Ave., Columbus, Ohio. *Mexican Bean Beetle.*
'39. Howland, A. F., 866 E. Leslie Drive, San Gabriel, Calif. *Tomato Insects.*
'23. HUBBELL, THEO. H., Dept. Biology, Univ. of Florida, Gainesville, Fla. (F. '39). *Orthoptera.*
'20. HUCKETT, H. C., Long Is. Vegetable Res. Farm, Riverhead, L. I., N. Y. (F. '38). *Muscidae.*
'30. Hughes, Miss Gwladys F., St. James Apts., Charles & Center Sts., Baltimore, Md. *Odonata, Orthoptera.*
'39. Hughes, John H., Div. of Ent., Univ. Farm, St. Paul, Minn. *Chrysomelidae.*
'16. HUNGERFORD, H. B., 323 Snow Hall, Univ. Kans., Lawrence, Kans. (F. '27). *Aquatic Hemiptera.*
'36. Hurlbut, Herbert S., Health and Safety Dept., Tenn. Valley Auth., Wilson Dam, Ala. *Culicidae.*
'29. Hutchins, Annie Laurie, (Mrs. R. E.), Box 184, State College, Miss. *Coccidae.*
'30. Hutchins, Ross E., Box 184, State College, Miss. *Lepidoptera.*
'38. Hutson, Ray, Dept. of Entomology, Michigan State College, E. Lansing, Mich. *Insecticides.*
'08. HYSLOP, JAMES A., Silver Spring, Maryland (F. '35). *Elateridae.*

'31. IDE, F. P., Dept. Biol., Univ. Toronto, Toronto 5, Ont., Canada. (F. '40). *Ephemeroptera.*
'19. *ILLINGWORTH, J. F., Bishop Museum, Honolulu, Hawaii. (F. '40). *Muscoidea.*
'28. Ingram, J. W., Box 387, Houma, La. *Sugarcane Insects.*
'14. ISELY, DWIGHT, Box 3, University Station, Fayetteville, Ark. (F. '34). *Chrysomelidae, Curculionidae.*
'36. Isely, F. B., Trinity Univ., Waxahachie, Texas. *Orthoptera.*
'22. Ishimori, Naoto, Faculty Agri., Imp. Univ., Hongo, Tokyo, Japan. *Silkworm Diseases.*
'27. Ives, J. D., Jefferson City, Tenn. *Cave Insects.*
'34. Ivy, Edward E., Box 1218, Waco, Texas.

'36. Jackman, Donald L., 627 Carondelet St., New Orleans, La., *Otitidae.*
'41. James, Brother Cyprian, Manhattan College, Spuyten Duyvil Pkwy., New York, N. Y. *Psyllidae.*
'38. James, Freburn L., Box 327, Saranac, Michigan. *Coleoptera.*
'31. JAMES, MAURICE T., Dept. of Ent., Colo. State College, Ft. Collins, Colo. (F. '40). *Stratiomyiidae.*
'30. Janes, Melvin J., Texas Exper. Sta., Alta Loma, Tex. *Economic Entomology.*
'35. Jaques, Harry E., 709 N. Main, Mount Pleasant, Iowa. *Insect Ecology.*
'30. Jaynes, H. A., 209 River St., Hoboken, N. J. *Tiphia of S. A.*
'25. JEANNEL, RENE, Mus. d'Historie Naturelle, 45 bis rue de Buffon, Paris 5e, France. (F. '30). *Trechus, Anophthalmes.*
'10. Jennings, H. R., High School of Com., Hayes & Van Ness Ave., San Francisco, Calif. *Diptera.*
'41. Jensen, Dilworth D., 1583 D St., San Bernardino, Calif. *Psyllidae.*
'15. Jewett, H. H., Agri. Exp. Sta., Lexington, Ky. *Tobacco and Forage Crop Insects.*
Ch. JOHANNSEN, O. A., 203 Parkway, Ithaca, N. Y. (F. '14, H. F. '39). *Diptera.*
'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'39. Johnson, John W., 112 Agricultural Hall, Univ. of California, Berkeley, Calif. *Saturniidae.*
'26. Johnston, H. G., P. O. Box 571, Phoenix, Arizona. *Miridae, Hemiptera.*
'27. Jones, Elmer T., 1204 Fremont, Manhattan, Kansas. *Hessian Fly.*
Ch. Jones, Frank M., 2000 Riverview Ave., Wilmington, Delaware. *Psychidae.*
'39. Jones, J. R. J. Llewellyn, "Arranmore," R. M. D. No. 1, Cobble Hill, British Columbia, Canada. *Ecology of Lepidopterous larvae.*
'41. Jones, Joseph W., Jr., Biological Laboratory, State Fish Hatchery, Springfield, Tenn.
'40. Just, Theodore K., P. O. Box 126, Notre Dame, Indiana.

'42. Kadner, Carl G., Dept. of Biology, Loyola University, Los Angeles, Calif. *Hippoboscidae, Culicidae.*
'34. Kagy, J. Franklin, care of Dow Chemical Co., P. O. Box 245, Seal Beach, Calif. *Insect Toxicology.*
'26. Kamal, Mohammed, Parasite Laboratory, Cotton Research B, Giza, Egypt. *Cotton Insects.*
'34. Kearns, Clyde W., Dept. Ent., Univ. of Illinois, Urbana, Ill. *Insecticides.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii. *Ecology.*
'14. KENNEDY, C. H., Dept. Zool. and Entomology, Ohio State University, Columbus, Ohio. (F. '27). *Odonata, Ants.*
'41. Kent, Ellis C., Avondale Apts. No. 21, Corvallis, Oregon. *Hemiptera.*
'36. Kessel, Berta B., 35 Elaine Ave., Mill Valley, Calif.
Ch. Kincaid, Trevor, Univ. Wash., Seattle, Wash. *Psychodidae, Dytiscidae.*
'12. KING, J. L., Box 150, Moorestown, New Jersey. (F. '32). *Biological Control.*
'23. KING, KENNETH M., Dominion Entomological Laboratory, Saskatoon, Sask., Canada. (F. '38). *Elateridae larvae, Noctuidae.*
'28. KING, WILLARD V., 4th Corps Area Lab., Ft. McPherson, Ga. (F. '38). *Culicidae.*
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'32. Klein, Adolph, Baleville, Newton, N. J. *Odonata.*
'38. Klots, Alexander B., Biology Dept., 17 Lexington Ave., New York, N. Y. *Lepidoptera.*
'11. KNIGHT, H. H., Dept. Zool., St. College, Ames, Iowa. (F. '28). *Hemiptera, Miridae.*
'40. Knight, Kenneth L., Mosquito Control Unit, Marine Barracks, New River, N. C. *Geometrid larvae.*
'40. Knigin, Tamarath, Engineer Infirmary, A. P. O. 807, Atkinson Field, British Guiana. *Culicidae, Ceratopogonidae.*
'24. KNOWLTON, GEORGE F., Agri. Exp. Sta., Logan, Utah. (F. '40). *Aphididae.*
'32. Knull, Mrs. Dorothy, 330 E. Dunedin Rd., Columbus, Ohio. *Erythroneura.*
'34. Knull, Josef N., Dept. Zool. & Ent., Ohio State Univ., Columbus, Ohio. *Cleridae, Elateridae, Buprestidae, Cerambycidae.*
'37. Knutson, Herbert C., Dept. of Zoology, Rhode Island State College, Kingston, Rhode Island. *Noctuidae.*
'17. Kraatz, Walter C., Univ. Akron, Akron, Ohio.
'40. Kretzschmar, Gerhard, care of Mrs. J. Kretzschmar, Princeton, Minn.
'41. Kriminetsky, Sol, Fernald Hall, Massachusetts State College, Amherst, Mass. *Morphology.*
'34. Krombein, Karl Von Vorse, Division of Insects, U. S. Nat. Mus., Washington, D. C. *Aculeate Hymenoptera.*
'41. Kuitert, Louis C., Dept. of Ent., Univ. of Kansas, Lawrence, Kansas. *Nepidae, Gerridae.*
'36. Kulash, Walter M., P. O. Box 99, Haydenville, Mass. *Collembola.*

'28. Lamiman, J. F., 2244 Summer St., Berkeley, Calif. *Acarina.*
'30. LANDIS, B. J., P. O. Box 218, Union Gap, Washington. (F. '40). *Biological Control.*
'40. Lange, W. Harry, Jr., Univ. of California, Court House, P. O. Box 1370, Salinas, Calif. *Lepidoptera.*
'25. Langford, George S., Dept. Ent., Univ. Maryland, College Park, Md. *Economic Entomology.*
'17. Langston, James M., A. & M. College, Miss. *Phyllophaga.*
'40. Lanham, Urless N., Scripps Institute, La Jolla, Calif. *Apoidea.*
'37. La Rivers, Ira, Box 1493, Reno, Nevada. *Odonata, Psychodidae.*
'14. Larrimer, W. H., U. S. D. A. Forest Service, Washington, D. C. *Cicadellidae.*
'38. Larson, N. P., Ent.-Zool. Dept. South Dakota State College, Brookings, S. D. *Physiology.*
'37. Lassman, G. W., Independencia No. 1, Jalopa, Vera Cruz, Mexico. *Culicidae.*
'13. LATHROP, F. H., Agri. Exp. Station, Orono, Maine. (F. '41). *Cicadellidae.*
'40. Latta, Randall, Bur. Ent. & P. Q., Washington, D. C. *Toxicology.*
'23. Lauderdale J. L. E., Box 368, Yuma, Arizona.

'17. Lawson, Paul B., 701 Ohio St., Lawrence, Kans. (F. '31). *Cicadellidae.*
'39. Leech, H. B., P. O. Box 308, Vernon, British Columbia, Canada. *Coleoptera.*
'12. Leiby, R. W., Comstock Hall, Cornell Univ., Ithaca, N. Y. (F. '40). *Embryology.*
'38. Leonard, Justin W., Hunt Creek Exp. Stat., P. O. Box 5, Lewiston, Mich. *Aquatic Insects.*
'28. Leonard, Mortimer D., care of Advertising Dept., The Dupont Co., Wilmington, Del. *Aphididae.*
'34. Le Veque, Norma, 1017 Maxwell Ave., Boulder, Colo. *Apoidea.*
'33. Lilly, John H., King Hall, Univ. of Wis., Madison, Wis. *Coleophoridae.*
'39. Lincoln, Charles, Farm Bureau Office, Oswego, N. Y. *Forage Crop Insects.*
'34. Lindgren, David L., Univ. of Calif., Citrus Exp. Sta., Riverside, California. *Toxicology.*
'39. Lindquist, Arthur W., Nice, Lake Co., Calif. *Chironomidae.*
'17. Lindsey, A. W., Box 612, Granville, Ohio. (F. '40). *Hesperioidea.*
'33. *Linsley, E. Gorton, 112 Agricultural Hall, Univ. of Calif., Berkeley, Calif. (F. '41). *Cerambycidae of World, Coleoptera of N. Am.*
'25. List, Geo. M., Agri. College, Fort Collins, Colo. (F. '32). *Cimicidae.*
'30. Livingston, E. M., 4425 Bienville Ave., New Orleans, La.
'31. Lloyd, Llewellyn, University, Leeds, England.
'19. Lobdell, Mrs. Gladys H., Rt. 2, Brevard, N. C. *Coccidae.*
'30. Loftin, U. C., Bureau Entomology & P. Q., Washington, D. C.
'38. Lowrie, Raymond E., 48 State St., P. O. Box 114, New Bedford, Mass.
'38. Ludwig, Daniel, Dept. of Biology, N. Y. Univ., 181st St. and Univ. Ave., New York, N. Y. *Physiology.*
'13. Luginbill, Philip, Box 495, Lafayette, Ind. (F. '41). *Phyllophaga.*
'34. Lund, Horace O., Division of Biological Science, Univ. of Georgia, Athens, Georgia. *Culicidae.*
Ch. Lutz, Frank E., 13 N. Central Ave., Ramsey, N. J. (F. '17). *Bees.*
'31. Lyle, Clay, State College, Miss. *Crustacea.*
'40. Lyman, F. Earle, care of T. V. A., Norris, Tenn. *Aquatic Insects, Ephemeroptera.*

'36. MacCreary, Donald, Del. Agri. Exp. Sta., Newark, Delaware. *Tabanidae, Culicidae.*
'32. MacLeod, Guy F., Dept. of Ent., Univ. of California, Berkeley, Calif. *Physiology.*
'40. MacSwain, J. W., Div. of Ent. & Parasitology, Univ. of Calif., Berkeley, Calif.
'20. McBride, O. C., Box 340, Honolulu, Hawaii. *Insecticides.*
'29. McClure, H. Elliott, 315 S. 17th St., Ord, Nebraska. *Ecology.*
'17. McCracken, Isabel, Box 1545, Stanford University, Calif. (F. '39). *Apoidea.*
'10. McDaniel, Eugenia, Agri. College, East Lansing, Mich. *Coccidae, Orthoptera.*
'30. McGovran, E. R., Bureau of Ent. & Plant Quar., Nat. Agr. Res. Center, Beltsville, Md. *Toxicology.*
'25. McGregor, E. A., Box 70, Whittier, Calif. (F. '38). *Tetranychidae.*
'11. McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D. C. (F. '34). *Insect Physiology.*
'32. McKinstry, Arthur Porter, 631 D St., Davis, Calif. *Microvelia.*

'32. Madden, A. H., Box 549, Quincy, Florida. *Economic Entomology.*
'34. Madden, Ruth A., 1415 High St., Des Moines, Iowa.
'41. Maddock, Darrell R., 450 Cross St., Ogden, Utah.
'17. Maheux, Georges, Dept. Agri., Parliament Bldg., Quebec, Canada. *Forest Insects.*
'40. Mangrum, James F., Lincoln Memorial Univ., Harrogate, Tenn. *Acarina.*
'33. Manis, Hubert C., Dept. of Entomology, Univ. of Idaho, Moscow, Idaho. *Onion, Potato Insects.*
'21. *Mank, Edith Webster, 12 Reservoir St., Lawrence, Mass. *Coleoptera.*
'21. Mank, Helen G., 12 Reservoir St., Lawrence, Mass.
'13. *Mann, Wm. M., Nat. Zool. Park, Washington, D. C. (F. '37). *Formicidae.*
'23. Manter, Jerauld A., Agri. College, Storrs, Conn. *Economic Entomology.*
'37. Manzelli, Manlio, 25 Leland Ave., Plainfield, N. J. *Hemiptera.*

'35. *Maple, John D., P. O. Box 47, Yokohama, Japan. *Physiology.*
'38. March, Ralph B., 303 Entomology Bldg., Univ. of Illinois, Urbana, Ill.
'22. Marcovitch, S., University Farm, Knoxville, Tenn. *Insecticides.*
'37. Markos, Basil G., 17 Mechanic St., Dover, New Hampshire. *Toxicology.*
Ch. MARLATT, C. L., 1521 16th St., N. W., Washington, D. C. (F. '07, H. F. '41). *Coccidae.*
Ch. MARSHALL, W. S., 139 E. Gilman St., Madison, Wis. (F. '17). *Morphology.*
'25. Martin, Chas. H., Box 65, College Hill Station, Cincinnati, Ohio. *Ecology.*
'34. Martorell, Luis F., P. O. Box 614, Rio Piedras, Puerto Rico. *Sugar Cane, Forest Insects.*
'38. Marvin, Philip H., Box 417, Oroville, Wash. *Biology of Melittobia.*
'21. Mason, Arthur C., Box 150, Moorestown, N. J. *Thysanoptera.*
'30. Mason, Horatio C., 151 West 11th Ave., Columbus, Ohio. *Tomato Fruitworm.*
Ch. MATHESON, ROBT., Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'34. Mattingly, Father H. E., St. Charles Coll., P. O. Box 303, Columbus, Ohio. *Coleoptera.*
'34. Maxson, Asa C., P. O. Box 46, Longmont, Colo. *Aphidae.*
'36. Mead, Albert R., Dept. of Zool., Cornell Univ., Ithaca, N. Y. *Chrysomelidae.*
'37. Medler, John T., Division of Entomology and Parasitology, Univ. of California, Berkeley, Calif. *Cicadellidae.*
'25. Meiners, Edwin, Rm. 238, 6651 Enright, St. Louis, Mo. *Lepidoptera.*
'32. Melampy, R. M., Louisiana Agri. Exp. Stat., University, La. *Physiology.*
Ch. MELANDER, A. L., City College of New York, New York, N. Y. (F. '14). *Diptera.*
'27. Melvin, Roy, Box 487, Menard, Texas. *Physiology.*
'39. Mendenhall, Eugene W., 97 Brighton Road, Columbus, Ohio.
'33. Menusan, Henry, Jr., Dept. of Entomology, Rutger's Univ., New Brunswick, N. J. *Physiology, Ecology.*
'32. Merino, Gonzalo, Bureau Plant Industry, Manila, P. I. *Cicadellidae.*
'23. Merrill, G. B., Plant Board, Seagle Bldg., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Nat. Hist. Bldg., Univ. Ill., Urbana, Ill. (F. '20). *Syrphidae.*
'39. Metcalf, Robert L., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Insect Physiology.*
'09. METCALF, Z. P., State College Station, Raleigh, North Carolina. (F. '34). *Homoptera.*
'35. MICHELBACHER, A. E., 112 Agri. Hall, Univ. of Calif., Berkeley, Calif. (F. '41). *Symphyla, Apoidea.*
'37. Michener, Charles D., 112 Agri. Hall, Univ. of Calif., Berkeley, Calif. *Apoidea.*
'17. MICKEL, CLARENCE E., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '35). *Mutillidae.*
'36. Miller, Albert, Dept. Tropical Medicine, Tulane Univ., 1430 Tulane Ave., New Orleans, La. *Culicidae.*
'31. Miller, Albert C., Box 2038, Pittsburgh, Pa. *Membracidae.*
'30. Miller, Forrest W., Biology Dept., Hartwick College, Oneonta, N. Y. *Aphididae.*
'37. Milliron, Herbert E., Dept. of Entomology, Purdue Agri. Exp. Station, Lafayette, Ind. *Chalcidoidea, Bombidae.*
'29. MILLS, HARLOW B., Dept. of Ent., Montana State Coll., Bozeman, Montana. (F. '37). *Collembola.*
'37. Milne, Lorus J., Randolph-Macon Woman's College, Lynchburg, Va. *Trichoptera.*
'25. Milum, Vern G., 104 Exp. Zool. Lab., Univ. of Illinois, Champaign, Ill. *Apiculture.*
'26. MINNICH, D. E., Dept. Zool., Univ. Minn., Minneapolis, Minn. (F. '39). *Behavior.*
'38. Miroyiannis, Stanley D., Dept. of Biology, Northeastern Univ., Boston, Mass. *Histology.*
'39. Mitchell, Robert T., 410 West Union St., West Chester, Pa. *Ichneumonidae and Braconidae.*
'21. MITCHELL, T. B., State College, Raleigh, N. Carolina. (F. '37). *Apoidea, Megachile.*

'21. *Moffatt, Elizabeth M., 328½ N. Rampart, Los Angeles, Calif. *Araneida.*
'39. Monk, J. W., Box 535, Fabens, Texas. *Diptera.*
'22. Montgomery, B. Elwood, Dept. Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'39. Moore, Geo. A., 359 Querbes Ave., Outremont, Quebec, Canada. *Hemiptera.*
'34. Moore, Joseph B., 1715 Fifth St., S. E., Minneapolis, Minn. *Insecticides.*
'39. Moore, Warren, Bon Air, Va. *Dermestidae.*
'08. Morgan, Ann H., Mt. Holyoke College, South Hadley, Mass. (F. '37). *Ephemeridae.*
Ch. Morgan, H. A., University Library, Univ. of Tennessee, Knoxville, Tenn.
'27. Morgan, W. P., R. R. 6, Box 414, Indianapolis, Ind. *Dermaptera.*
Ch. Morrill, A. W., 1612 W. Glenoaks Blvd., Glendale, Calif. (F. '39). *Biological Control.*
'12. Morrison, Harold, Bureau of Entomology and Plant Quarantine, Washington, D. C. (F. '28). *Coccidae.*
'08. Mosher, Edna, R. R. No. 1, Newport, Nova Scotia, Canada. (F. '20). *Lepidoptera.*
'20. Mote, Don C., St. Agri. College, Corvallis, Oregon. *Economic Entomology.*
'29. Moulton, Dudley, 35 Elwood St., Redwood City, Cailf. (F. '31). *Thysanoptera.*
'15. Muesebeck, C. F. W., Bureau of Entomology and Plant Quarantine, Washington, D. C. (F. '34). *Braconidae, Bethylidae.*
'38. Mullen, James A., 135 Siwanoy Blvd., Tuckahoe, N. Y. *Isoptera.*
'36. Mulrennan, J. A., Escambia County Health Dept., Pensacola, Fla. *Culicidae.*
'30. Mundell, R. C., care Thomas Cook & Sons, Bankers, 4 Kashmir Gate, Delhi, India. *Parasitic Hymenoptera.*
'27. *Munro, J. A., State College Station, Fargo, No. Dak. *Orthoptera, Diptera.*
'35. *Murray, William D., State Teachers College, Bemidji, Minn. *Sphecidae.*
'28. Musgrave, Anthony, Australian Museum, College St., Sydney, New South Wales, Australia. (F. '41). *Nycteribiidae.*
'27. Musgrave, Paul N., Box 426, Huntington, West Virginia. *Dryopidae.*
'15. Muttkowski, R. A., Univ. Detroit, Detroit, Mich. (F. '40). *Physiology, Ecology.*

'35. Nagel, R. H., Forest Insect Laboratory, Bur. Ent. & P. Q., Coeur d'Alene, Idaho.
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07, H. F. '35). *Odonata, Ephemerida.*
'21. Neiswander, C. R., Ohio Agri. Exp. Sta., Wooster, Ohio. *Insects of ornamentals.*
'28. Neiswander, R. B., Agri. Exp. Sta., Wooster, Ohio. *Fruit Insects.*
'39. Nesbitt, Herbert H. J., 34 Lakeside Ave., Ottawa, Ontario, Canada. *Acarina.*
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa. *Economic Entomology.*
'34. Nevin, F. Reese, 316 Columbia St., Ithaca, N. Y. *Morphology of Acarina.*
Ch. Newcomer, E. J., Box 1291, Yakima, Washington. *Fruit Insects.*
'07. Newell, Wilmon, 504 East Church St., Gainesville, Fla. *Economic Entomology.*
'15. Newman, Geo. B., 246 E. Hamilton Ave., State College, Pa. *Insect Histology.*
'28. Newton, Richard C., 121 East Story St., Bozeman, Montana. *Alfalfa weevil.*
'38. Nicholson, H. Page, Div. of Ent., Univ. Farm, St. Paul, Minn. *Simuliidae.*
'31. Nickels, C. B., Box 209, Bureau of Entomology, Brownwood, Texas. *Pecan Insects.*
'22. Noble, W. B., Bur. of Ent. & Pl. Q., Box 1857, Sacramento, Calif. *Hessian Fly.*
'38. Noland, Lowell E., Biology Bldg., Univ. of Wisconsin, Madison, Wis.
'17. *Notman, Howard, Circle Rd., Dougan Hills, Staten Island, N. Y. *Carabidae, Staphylinidae.*
'37. Nye, William P., 31 Federal Ave., Logan, Utah. *Forest Insects.*

'31. O'Byrne, Harold I., R. F. D. No. 1, Box 350, Glencoe, Mo. *Ecology, Lepidoptera.*
'08. O'Kane, Walter C., Durham, New Hampshire. (F. '24).
'29. Oman, Paul W., Bur. Ent. & P. Q., Washington, D. C. (F. '40). *Homoptera.*

'37. O'Neill, William J., Tree Fruit Branch Exp. Station, Box 596, Wenatchee, Wash. *Fruit Insects.*
'34. Oosthuizen, M. J., School of Agriculture, Potchefstroom, South Africa. *Stored Grain Insects.*
Ch. OSBORN, HERBERT, Ohio St. Univ., Columbus, Ohio. (F. '07, H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., 2346 Brandon Road, Columbus, Ohio. *Cicadellidae.*
Ch. OSBURN, R. C., Ohio State Univ., Columbus, Ohio. (F. '17). *Syrphidae.*
'20. Otanes, Faustino Q., Bureau of Plant Industry, Manila, Philippine Is. *Economic Entomology.*
'36. Owen, Wm. Bert, Dept. of Zool., Univ. of Wyoming, Laramie, Wyo. *Culicidae.*
'25. Ozburn, Reg. H., Ont. Agri. College, Guelph, Ontario, Canada. *Insect Histology.*

'15. Packard, Clyde M., Bureau of Ent. & Plant Quar., Washington, D. C. *Cereal and Forage Insects.*
'18. Painter, H. R., Box 495, Lafayette, Indiana. *Phyllophaga.*
'19. PAINTER, R. H., Dept. Ent., K. S. C., Manhattan, Kansas. (F. '35). *Diptera, Bombyliidae.*
'39. Palm, Charles E., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Forage Crop Insects.*
'37. Palmer, Boyd B., Polytechnic Institute, San German, Puerto Rico. *Trichoptera.*
'27. PALMER, MIRIAM A., 621 So. Howes St., Fort Collins, Colo. (F. '37). *Aphidae.*
'27. PARK, ORLANDO, Dept. Zool., Northwestern Univ., Evanston, Ill. (F. '40). *Pselaphidae.*
'39. Parker, Barbara M., 1125 Elm Ridge Drive, Glencoe, Ill.
'24. Parker, D. E., Box 156, Bexley Station, Columbus, Ohio. *Insect vectors of Elm diseases.*
'25. PARKER, H. L., South American Parasite Lab., Blanca del Tabare, 2950, Montevideo, Uruguay. (F. '40). *Parasitic Hymenoptera.*
'18. PARKER, J. B., 1217 Lawrence St. N. E., Washington, D. C. (F. '40). *Bembicidae.*
'37. Parker, J. R., Bureau of Ent. & Pl. Quar., Bozeman, Montana. *Orthoptera.*
'24. Parker, R. L., Dept. Ent., K. S. C., Manhattan, Kansas. *Apiculture.*
'34. Parks, Hal B., Route 1, Box 368, San Antonio, Texas. *Diptera, Hymenoptera.*
'16. Parks, H. B., Route 1, Box 368, San Antonio, Texas. *Apiculture.*
'18. Parks, T. H., Dept. Ent., Ohio St. Univ., Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Texas. *Diptera.*
Ch. PARROTT, P. J., Agri. Exp. Sta., Geneva, N. Y. (F. '14).
'12. Parshley, H. M., Dept. Zool., Smith College, Northampton, Mass. *Heteroptera.*
'32. Parsons, Carl T., 205 West 57th St., New York City, N. Y.
'34. Parten, Herbert L., Div. of Ent., Univ. Farm, St. Paul, Minn. *Greenhouse Insects.*
'32. dos Passos, Cyril F., Washington Corners, Mendham, N. J. *Lepidoptera.*
Ch. *PATCH, EDITH M., Agri. Exp. Sta., Orono, Maine. (F. '14). *Aphididae.*
'35. Paulian, Renaud, Laboratoire d'Entomologie, Museum d'Histoire Naturelle, 45 bis Rue de Buffon, Paris V, France. *Scarabaeidae, Corylophidae.*
'35. Paullus, Harold J., Crystal City, Mo.
'23. PAYNE, NELLIE M., care of American Cyanamid Co., Boston Post Road, Stamford, Conn. (F. '40). *Physiology.*
'20. PEAIRS, L. M., Morgantown, West Va. (F. '40).
'34. Pechuman, La Verne L., 210 W. Center St., Medina, N. Y. *Tabanidae.*
'40. Pederson, Calvin E., Tenth Naval District, San Juan, Puerto Rico.
'37. Pelton, John Z., 80½ E. 5th St., Chillicothe, Ohio. *Aquatic Insects.*
'35. Penner, Lawrence R., Dept. Zoology, University of Connecticut, Storrs, Conn. *Araeopidae.*
'30. Pepper, Bailey B., Dept. Ent., Agri. Exp. Sta., New Brunswick, N. J. *Biological Control.*
'32. Pepper, James Hubert, Mont. State College, Bozeman, Mont. *Insecticides.*
'29. Peters, Harold T., Div. of Ent., Univ. Farm, St. Paul, Minn. *Siphonaptera.*

'39. Peterson, Allan G., Div. Ent., Univ. Farm, St. Paul, Minn. *Potato Insects.*
'11. PETERSON, ALVAH, Dept. Ent., Ohio St. Univ., Columbus, Ohio. (F. '28). *Biological Control.*
'37. Peterson, Lloyd O. T., Indian Head, Saskatchewan, Canada. *Forest Entomology.*
'39. Petrakis, Manuel M., Rm. 128, Natural Resources Bldg., Univ. of Illinois, Urbana, Ill.
'40. Pettit, Lincoln G., 59 Harrison Ave., Baldwin, Long Island, N. Y. *Dermestidae.*
Ch. PETTIT, R. H., Dept. Ent., Michigan State College, East Lansing, Mich. (F. '39). *Coccidae.*
'07. PETRUNKEVITCH, ALEXANDER, Yale Univ., New Haven, Conn. (F. '37). *Arachnida.*
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'38. Phillips, Maurice E., Hanshow Road, Ithaca, N. Y.
'12. Phillips, W. J., Box 255, Charlottesville, Va. *Harmolita.*
'37. Phillips, W. Levi, 985 So. Third East, Salt Lake City, Utah. *Lepidoptera.*
Ch. PIERCE, W. DWIGHT, Los Angeles County Museum, Exposition Park, Los Angeles, Calif. (F. '30). *Rhynchophora.*
'35. Pinkus, L. F., 10120 Manchester Road, Kirkwood, Mo. *Arachnida.*
'41. Platt, Fred R., 218 W. Center St., Covina, Calif. *Coccidae, Coleoptera.*
'41. Pletsch, Don, Dept. of Entomology, Montana State College, Bozeman, Mont. *Psyllidae, Myrmeleonidae.*
'39. Plumb, George H., Agri. Exp. Station, New Haven, Conn. *Anoplura.*
'28. Plummer, C. C., Calzada Tacuba 295, Colonia Anahuac, Mexico, D. F., Mexico. *Membracidae.*
'18. Poos, Fred W., 3225 Albemarle St., Arlington, Va.
'23. Porter, B. A., Bureau Entomology & Pl. Q., Washington, D. C. *Fruit Insects.*
'34. Post, R. L., Dept. of Ent., Oregon State College, Corvallis, Ore. *Orthoptera.*
'26. Potts, Samuel F., 56 Hillhouse Ave., New Haven, Conn. *Toxicology, Physiology.*
'37. Powell, Dwight, 403 S. McCullough, Urbana, Ill. *Insecticides.*
'36. Pratt, Harry D., Div. of Entomology, Univ. Farm, St. Paul, Minn. *Ichneumonidae.*
'16. Price, W. A., Univ. Ky., Lexington, Ky. *Economic Entomology.*
'32. *Pritchard, A. Earl, Div. of Ent., Univ. Farm, St. Paul, Minn. *Asilidae, Itonididae.*
'40. Pritchett, John C., 422 Federal Office Bldg., Seattle, Wash.
'28. PROCTER, WM., Bar Harbor, Maine. (F. '40). *Insects of Mt. Desert Region.*
'33. Putnam, W. L., Dom. Ent. Lab., Vineland Station, Ontario, Canada. *Chrysopidae.*

'36. Quarterman, Kenneth D., Box 989, Gulfport, Miss. *Cimicidae.*

'14. RAU, PHIL, 549 E. Argonne Drive, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'23. READIO, PHILIP A., Dept. of Ent., Cornell Univ., Ithaca, N. Y. (F. '37). *Reduviidae.*
'23. Reed, W. D., P. O. Box 5271, Richmond, Va. *Tobacco Insects.*
'30. Rees, Don M., Univ. Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Jos. A., 415 Federal Bldg., Buffalo, N. Y. *Chrysomelidae, Fulgoridae.*
Ch. REHN, J. A. G., Acad. Nat. Sciences, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'34. Rice, Paul L., Alma College, Alma, Mich. *Chalcidoidea.*
'30. RICHARDS, A. GLENN, JR., Zoological Laboratories, Univ. of Penn., 38th St. and Woodland Ave., Philadelphia, Pa. (F. '38). *Noctuidae.*
'14. RICHARDSON, CHAS. H., Dept. Ent., Ia. St. Coll., Ames, Ia. (F. '31). *Physiology.*
'29. RICHARDSON, H. H., Beltsville Research Center, Beltsville, Maryland. (F. '41). *Physiology.*
'28. Richmond, Edward A., Agri. Exp. Sta. Bldg., State College, Pa. *Hydrophilidae.*

'39. Riedel, F. Atherton, 2894 Dexter St., Denver, Colo.
'39. Riegel, Garland T., 304 Entomology Bldg., Univ. of Ill., Urbana, Ill. *Braconidae.*
'22. Ries, Donald T., Starved Rock State Park, Utica, Ill. *Cephidae, Siricidae.*
'40. Rihard, Paul T., P. O. Box 71, Weslaco, Texas. *Culicidae.*
'29. Riley, Merrill K., Box 57, Kaneohe, Hawaii. *Coccidae.*
Ch. RILEY, WM. A., Div. Ent., Univ. Farm, St. Paul, Minn. (F. '14). *Parasitology.*
'39. Rings, Roy W., 1462 W. Second Ave., Columbus, Ohio. *Cerambycidae.*
'33. Ritcher, Paul O., Agr. Exp. Station, Lexington, Ky. *Phyllophaga.*
'36. Ritchie, C. L., 439 U. S. Courthouse, Portland, Oregon. *Coccidae, Lepidopterous larvae.*
'25. Rivnay, Ezekiel, Agri. Exp. Stat., Rehoboth, Palestine. *Thysanoptera.*
'39. Roark, R. C., Bur. Ent. & P. Q., U. S. D. A., Washington, D. C. *Insecticides.*
'40. Roberts, H. Radclyffe, Villa Nova, Pa. *Acrididae.*
'31. Roberts, J. Harvey, Box 8729, University, La. *Trichoptera.*
'28. Roberts, R. A., 820 Insurance Exchange Bldg., Denver, Colo. *Mantidae.*
'15. Robinson, J. M., Box 671, Auburn, Alabama.
'26. ROBINSON, WM., Burnt Mills Hills, Silver Spring, Maryland. (F. '39). *Physiology.*
'41. Rockstein, Morris, Div. of Ent., Univ. Farm, St. Paul, Minn.
'13. Rockwood, L. P., Forest Grove, Oregon. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Univ. Colo. Museum, Boulder, Colo. *Nomada.*
'15. Rogers, J. Speed, Box 2666, Univ. Sta., Gainesville, Fla. *Tipulidae.*
'41. Rogoff, William M., Dept. of Entomology, Cornell Univ., Ithaca, N. Y.
'27. ROHWER, S. A., Bur. Ent. & Pl. Q., Washington, D. C. (F. '29) *Hymenoptera.*
'14. Rosenfeld, A. H., Boite Postale 763, Cairo, Egypt. *Sugar Cane Insects.*
'25. Rosewall, O. W., Box 8729, Dept. Ent., Louisiana State Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'39. Ross, Edward S., Dept. Ent., Calif., Acad. Sci., San Francisco, Calif. *Histeridae, Embioptera.*
'31. ROSS, HERBERT H., St. Nat. Hist. Surv., Urbana, Ill. (F. '37). *Tenthredinoidea.*
'12. Ross, Wm. A., Vineland Station, Ontario, Canada. *Aphididae.*
'40. Roth, Louis M., 351 East 45th St., Brooklyn, N. Y.
'36. Rozeboom, Lloyd Eugene, School of Hygiene and Public Health, 615 No. Wolf St., Baltimore, Md. *Culicidae.*
'14. Ruckes, Herbert, 167–11 33rd Ave., Flushing, L. Is., New York. *Pentatomidae.*
'39. Rude, Clifford S., 1214 W. Masonic, Gainesville, Fla. *Ixodidae.*
Ch. RUGGLES, A. G., University Farm, St. Paul, Minn. (F. '35).

'33. *SABROSKY, CURTIS W., Dept. of Ent., Mich. State Coll., East Lansing, Mich. (F. '41). *Chloropidae.*
'41. Sailer, Reece I., 316 Snow Hall, Univ. of Kansas, Lawrence, Kans. *Hemiptera.*
'38. Sailsbury, Murl B., Genl. Del., Fisher, Illinois. *Chrysomelid larvae.*
'29. Sakimura, Kay. Pineapple Exp. Station, Honolulu, Hawaii. *Thysanoptera.*
'37. Sampson, William W., 156 So. 14th St., Richmond, Calif. *Aphididae, Aleurodidae.*
'31. Sanderson, Milton W., 422 Northwest St., Fayetteville, Ark. *Coleoptera.*
'31. Sargent, Wm. D., Biology Dept., The City College, 17 Lexington Ave., New York, N. Y. *Odonata, Ephemerida.*
'07. SATTERTHWAIT, A. F., 806 Ohio St., Urbana, Illinois. (F. '30). *Calendra.*
'29. Scaramuzza, L. C., Central Baragua, Prov. of Camaguay, Cuba. *Sugar Cane Insects.*
'30. Schaefer, Paul E., Dept. Zool., Univ. of New Hampshire, Durham, N. H. *Morphology.*
'25. Schear, E. W. E., 107 W. Park St., Westerville, Ohio. *Hemiptera, Diptera, Hymenoptera.*
'30. Schlosberg, Morris, 1920 Parkwood Ave., Toledo, Ohio. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii. *Ecology.*
'33. Schmidt, Helen D. O'Neil, Box 3166, Honolulu, Hawaii. *Trichoptera.*
'20. Schmieder, Rudolf G., Zool. Lab., Univ. Pa., Philadelphia, Pa.

'32. Schmitt, John B., 411 White Horse Ave., Trenton, N. J. *Morphology.*
'34. Schmitt, T. J., Jr., 820 Insurance Exchange Bldg., Denver, Colo. *Scolytidae.*
Ch. Schoene, W. J., Agri. Exp. Sta., Blacksburg, Va.
'36. Schoof, Herbert F., Dept. Zoology, N. C. State College, Raleigh, N. C. *Chrysomelidae.*
'29. Schroeder, H. O., Halstead, Kansas. *Ixodoidea, Argasidae.*
'37. Schroeder, Philip M., 1979 Ashland Ave., St. Paul, Minn. *Forest Insects.*
'40. Schuh, Joe, Dept. Ent., Oregon State College, Corvallis, Oregon. *Odonata.*
'32. Schumaker, George K., 1515 Chew St., Allentown, Pa. *Coleoptera.*
'26. SCHWARDT, H. H., Dept. Ent., Cornell Univ., Ithaca, N. Y. (F. '35). *Tabanidae.*
'26. SCHWARZ, HERBERT F., Am. Mus. Nat. Hist., 77th St. & Cent. Park West, New York City, N. Y. (F. '37). *Meliponidae.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Lemna Insects.*
'25. SCULLEN, H. A., 325 So. 13th St., Corvallis, Oregon. (F. '40). *Cerceridae.*
'23. Seamans, H. L., Dom. Ent. Lab., Lethbridge, Alberta, Canada. *Muscoidea.*
'41. Sears, Jack W., Dept. of Zoology, Univ. of Texas, Austin, Texas.
'36. Seevers, Charles, Central Y. M. C. A. College, 19 South LaSalle St., Chicago, Ill. *Termitophiles.*
'38. Semans, F. Merrick, Youngstown College, Youngstown, Ohio.
'29. Setty, L. R., Park College, Parkville, Mo. *Mecoptera, Bittacus.*
'08. SEVERIN, H. C., South Dakota State College, Brookings, South Dakota. (F. '39). *Orthoptera, Homoptera, Heteroptera.*
'37. Shadle, Albert R., Dept. Biology, University of Buffalo, Buffalo, N. Y.
'07. SHAFER, GEO. D., 321 Melville Ave., Palo Alto, Calif. (F. '41). *Physiology.*
'18. *SHANNON, R. C., Caixa Postal 49, Rio de Janeiro, Brazil. (F. '34). *Diptera.*
'35. Shaw, Frank R., Fernald Hall, Mass. State College, Amherst, Mass. *Mycetophilidae.*
'29. Shaw, John G., Hacienda de Santa Engracia, Santa Engracia, Tamps., Mexico.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy Sts., Champaign, Ill. (F. '20). *Ecology.*
'22. SHEPARD, HAROLD H., Univ. Farm, St. Paul, Minn. (F. '39). *Hesperiidae.*
'17. Sherman, Franklin, Div. Ent., Clemson College, South Carolina. *Acrididae, Cerambycidae, Cicindelidae.*
'11. SHERMAN, JOHN D., JR., 132 Primrose Ave., Mt. Vernon, N. Y. (F. '39). *Dytiscidae.*
'34. Shields, S. E., Box 655, New Smyrna Beach, Florida. *Culicoides.*
'35. *Shockley, Wilfred, Apt. 110, 1550 Sherman St., Denver, Colo. *Cerambycidae, Decticinae.*
'28. Shropshire, Leslie H., Box 85, Des Plaines, Ill. *Economic Entomology.*
Ch. SHULL, A. FRANKLIN, 431 Highland Rd., Ann Arbor, Mich. (F. '39). *Aphididae.*
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'32. Silvey, J. K. Gwynn, Dept. of Biology, North Texas State Teachers' College, Denton, Texas. *Coleoptera.*
'35. Simizu, Tunehisa, Imp. Pl. Quar. Serv., Nagoya Custom House, Nagoya, Japan. *Bruchidae, Diptera.*
'29. Simmons, Perez, 712 Elizabeth St., Fresno, Calif. *Dried Fruit Insects.*
'30. Simmons, S. W., P. O. Box 789, Panama City, Fla. *Medical Entomology.*
'39. Simonds, Wm. E., Agricultural Bldg., Embarcadero and Mission, San Francisco, Calif. *Elateridae.*
'30. *Simpson, Geddes W., Holmes Hall, Orono, Me. *Insects and Plant Diseases.*
'38. Singleton, J. M., 5217 Connecticut Ave. N. W., Washington, D. C. *Quarantines.*
'38. Skoog, Fred E., Bur. of Ent. & Pl. Quar., Bozeman, Montana. *Acrididae.*
'32. Smith, Carroll N., Box 115, Vineyard Haven, Mass. *Ixodidae.*
'32. Smith, Chas. E., Agricultural Center, University, La. *Truck Crop Insects.*
'35. Smith, Clyde F., Dept. of Entomology, Univ. of North Carolina, Raleigh, N. C. *Aphididae.*
'27. Smith, Floyd F., Research Center, Beltsville, Maryland.
'35. Smith, Frank K., 2228 Elizabeth St., Pueblo, Colo. *Aquatic Coleoptera.*

'37. Smith, Gordon E., 811 Manly Ave., Paris, Tenn. *Culicidae.*
'41. Smith, Gordon F., Dept. of Ent. & Parasitology, Univ. of California, Berkeley, Calif. *Syrphidae.*
'28. Smith, Herbert D., 209 River St., Hoboken, N. J. *Ichneumonidae.*
'35. Smith, Howard W., Rear 186 West Woodruff Ave., Columbus, Ohio.
'37. Smith, Marion E., Fernald Hall, Mass. State College, Amherst, Mass. *Arctiidae.*
'19. SMITH, MARION R., Rm. 377, U. S. National Museum, Washington, D. C. (F. '38). *Formicidae.*
'39. Smith, Myron W., 728 Dermon Bldg., Memphis, Tenn. *Curculionidae.*
'36. Smith, Ralph H., Univ. of Calif., 405 Hilgard Ave., Los Angeles, Calif. *Hemiptera.*
'14. SMITH, ROGER C., Dept. Ent., Kan. State College, Manhattan, Kansas. (F. '31). *Neuroptera.*
'38. Smith, Septima C., Box 1446, University, Alabama. *Odonata.*
'18. Snapp, Oliver I., Box 527, Fort Valley, Georgia. *Rhynchophora.*
'39. Snipes, Benjamin T., Powell, Wyo. *Siphonaptera.*
'24. SNODGRASS, R. E., 3706 Thirteenth St., N. W., Washington, D. C. (F. '27). *Morphology.*
'36. Snyder, Fred M., 3563 88th St., Jackson Heights, L. I., New York. *Muscoidea.*
'38. Sommerman, Kathryn M., Dept. of Ent., Univ. of Illinois, Urbana, Ill. *Corrodentia.*
'26. Sorenson, Chas. J., Agri. Exp. Sta., Logan, Utah. *Miridae.*
'14. *Spencer, G. J., Univ. Brit. Col., Vancouver, Brit. Col., Canada. *Trypetidae.*
'19. SPENCER, HERBERT, Station Hosp., Camp Shelby, Miss. (F. '37). *Hymenoptera.*
'31. Spieth, Herman T., College of City of New York, Convent Ave. & 139th St., New York, N. Y. *Ephemeroptera.*
Ch. Spooner, Chas. S., 1436 Seventh St., Charleston, Ill. *Fulgoridae.*
'40. Sprague, Mrs. James M., 72 Kirkland St., Cambridge, Mass. *Aquatic Hemiptera.*
'29. Spruijt, F. J., Trap Rock Farm, Deerfield, Mass. *Formicidae.*
'39. Stafford, Eugene M., Rt. 8, Box 721, Fresno, Calif. *Vegetable Insects.*
'10. Stafford, E. W., State College, Miss. *Mallophaga.*
'38. Stains, George S., Dept. Ent., Utah Agri. Coll., Logan, Utah. *Conopidae; Simuliidae.*
'30. Stanford, J. S., Agri. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agri. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'17. Stearns, Louis A., Agri. Exp. Sta., Newark, Del. *Cercopidae, Cicadellidae.*
'35. Stehr, William C., Dept. of Biology, Ohio Univ., Athens, Ohio. *Coccinellidae, Carabidae.*
'38. Steiner, Harold M., Box 123, Arendtsville, Pa. *Fruit Insects.*
'27. Steiner, L. F., 1415 St. Clair St., Vincennes, Indiana. *Fruit Insects.*
'29. Steinweden, John B., Bur. Nursery Service, State Dept. Agri., Sacramento, Calif. *Coccidae, Thysanoptera.*
'31. STEWART, M. A., Div. of Ent. & Parasitology, Univ. of Calif., Davis, Calif. (F. '41). *Siphonaptera.*
'15. Stiles, Chas. F., Box 29, Stillwater, Okla.
'38. Stitt, Loyd L., Box 273, Tempe, Arizona. *Miridae.*
'27. Stone, Alan, Bureau Entomology and Plant Quar., Washington, D. C. (F. '40). *Simuliidae, Tabanidae.*
'36. Stone, Philip C., Dept. of Entomology, Univ. of Missouri, Columbia, Missouri. *Ixodidae.*
'28. Stone, Wm. E., Laboratorio Entomologica, Calzada, Mexico—Tacuba 295, Colonia Anahuac, D. F., Mexico.
'12. Strickland, E. H., Univ. Alberta, Edmonton, Alberta, Canada. *Elateridae.*
'34. Strom, Lawrence G., 604 A South 28th St., Milwaukee, Wis. *Aphiidae.*
'31. Summerour, A. R., Box 90, Lucedale, Miss.
'23. Sweetman, Harvey L., State College, Amherst, Mass. *Ecology.*
'20. SWEZEY, OTTO H., 2048 Lanihuli Drive, Honolulu, Hawaii. (F. '30). *Delphacidae.*

'37. Talbot, Mary, Lindenwood College, St. Charles, Missouri. *Formicidae.*
'36. Tanner, M. C., 2907 Lincoln Ave., Ogden, Utah. *Plecoptera.*
'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
Ch. Tanquary, M. C., Univ. Farm, St. Paul, Minn. *Apiculture.*
'40. Tarshis, Irvin, 3906 N. E. Hoyt St., Portland, Ore.
'31. Tate, H. D., Dept. of Ent., College of Agriculture, Lincoln, Nebr. *Ixodidae.*
'36. *Tauber, Oscar E., Zool. Dept., Iowa State College, Ames, Iowa. *Physiology.*
'22. Taylor, Leland H., Dept. Botany & Zool., W. Va. Univ., Morgantown, W. Va. *Bees, Wasps.*
'29. Taylor, R. L., Dept. Biology, College of William and Mary, Williamsburg, Va. *Parasitic Hymenoptera.*
'34. *Telford, Horace S., Dept. Ent., State College, Fargo, N. D. *Syrphidae.*
'40. Thatcher, Theodore O., care F. V. Thatcher, River Heights, Logan, Utah. *Scolytidae, Buprestidae, Cerambycidae.*
'21. Thomas, Chas. A., 120 S. Broad St., Kennett Square, Chester County, Pa. *Elateridae, Scarabaeidae.*
'32. Thomas, Edward S., Ohio State Museum, Ohio St. Univ., Columbus, Ohio. *Orthoptera.*
'15. Thomas, F. L., College Station, Texas. *Cotton Insects.*
'39. Thompson, W. L., Box 1074, Lake Alfred, Fla. *Citrus Insects.*
'22. Tietz, Harrison M., Dept. Zool., Pa. St. College, State College, Pa. *Noctuidae.*
'11. TIMBERLAKE, P. H., Citrus Exp. Sta., Riverside, Calif. (F. '38). *Encyrtidae.*
'34. Ting, Peter C., State Agri. Bldg., San Francisco, Calif. *Rhynchophora.*
'23. Tissot, A. N., Agr. Exp. Sta., Gainesville, Fla. *Aphididae.*
'26. Todd, F. E., University Farm, Davis, Calif. *Apiculture.*
'33. Tongyai, M. R. Chakratong, Department of Agriculture, Bangkok, Thailand, *Buprestidae.*
'29. Tosawa, Nobuyoshi, Kotoen, near Nishinomiya, Hyogo-ken, Japan. *Hymenoptera.*
'33. Townes, Henry K., Jr., U. S. National Museum, Washington, D. C. *Ichneumonidae, Chironomas.*
'28. Townsend, Lee H., Dept. Ent., Univ. of Kentucky, Lexington, Ky. *Neuroptera.*
'36. Trager, Wm., Rockefeller Institute, Princeton, N. J. *Insect Nutrition.*
'39. Traub, Robert, Dept. of Ent., Univ. of Illinois, Urbana, Ill. *Siphonaptera.*
'30. TRAVER, (MISS) JAY R., Fernald Hall, Mass. State College, Amherst, Mass. (F. '35). *Ephemeridae.*
'30. Travis, Bernard V., Box 655, New Smyrna Beach, Fla. *Culicidae.*
'39. Trembley, Helen L., Bur. Ent. & Pl. Quar., Washington, D. C. *Ixodidae.*
'34. Trippel, A. W., Indiana Dept. of Conservation, Box 408, Auburn, Indiana. *Chrysomelidae.*
'38. Tuck, Joseph B., Morrisville, Mo. *Orthoptera.*
'28. Tulloch, Geo. S., Dept. Biology, Brooklyn College, Brooklyn, N. Y. *Morphology.*
'08. Turner, Wm. F., 310 Woodward Ave., Chattanooga, Tenn.
'29. Tuthill, L. D., Dept. of Ent., Ia. St. College, Ames, Ia. *Psyllidae, Fulgoridae.*

'39. Uchida, T., Entomological Institute, Hokkaido Imp. Univ., Sapporo, Japan. *Ichneumonidae.*
'20. Uichanco, L. B., Agri. College, Laguna, P. Is. *Hemiptera.*
'32. USINGER, ROBERT L., Div. of Ent. & Parasitology, Univ. of Calif., College of Agri., Davis, Calif. (F. '41). *Heteroptera, except Corixidae.*

'22. Vance, Arlo M., 1920 Parkwood Ave., Toledo, Ohio. *Ecology.*
Ch. Van Dine, D. L., 805 Crescent Drive, Alexandria, Va. *Fruit Insects.*
Ch. VAN DYKE, E. C., Dept. of Entomology, California Acad. Sci., Golden Gate Park, San Francisco, Calif. (F. '17). *Coleoptera.*
'39. Vazquez, Leonila (Miss), Instituto de Biologia, Casa del Lago, Chapultepec D. F., Mexico. *Psychidae.*

'37. Viado, Getulio B., Agricultural College, Laguna, P. I. *Toxicology.*
'40. Viets, Dorothydean, Dept. Zool. & Ent., North Carolina State College, Raleigh, N. C. *Hemiptera.*
'40. Vogt, George B., Dept. of Ent., Univ. of Maryland, College Park, Md. *Coleoptera, Hemiptera.*

'15. WADE, J. S., Bur. Ent. & Pl. Quar., Washington, D. C. (F. '37). *Coleoptera.*
'21. WADLEY, F. M., 3215 N. Albemarle, Arlington, Va. (F. '39). *Aphididae.*
'18. Wainwright, C. J., 172 Hamstead Rd., Handsworth, Birmingham, England. *Tachinidae.*
'22. Walkden, Herbert H., Bur. Ent. & Pl. Quar., 103 Insectary Bldg., Iowa State College, Ames, Iowa. *Noctuidae.*
'10. WALKER, E. M., Dept. Biol., Univ. Toronto, Toronto, Ontario, Canada. (F. '14). *Odonata, Orthoptera.*
'30. Walker, Harry G., Va. Truck Exp. Sta., P. O. Box 267, Norfolk, Va. *Economic Entomology.*
'38. Wallace, George E., Dept. Ent., Carnegie Museum, Pittsburgh, Pa. *Chalcididae.*
'23. Wallace, Hugh E., 210 Santa Rita, Modesto, Calif.
'32. WALLEY, G. STUART, Ent. Branch, Ottawa, Ontario, Canada. (F. '41). *Hymenoptera, Hemiptera.*
'37. Walter, E. V., Box 495, Lafayette, Indiana. *Economic Entomology.*
'17. WALTON, WM. R., Bur. Ent. & Pl. Quar., Washington, D. C. (F. '37).
'36. Wardle, Robert A., Dept. of Zool., Univ. of Manitoba, Winnipeg, Manitoba, Canada.
'13. WATSON, J. R., Agri. Exp. Station, Univ. Fla., Gainesville, Fla. (F. '39). *Thysanoptera.*
'25. Watson, S. A., Wilmington College, Wilmington, Ohio. *Miridae, Hemiptera.*
'16. Webber, Ray T., 8 Whippany Road, Morristown, N. J. *Tachinidae.*
'34. Weber, Neal A., Dept. of Biology, University Station, Grand Forks, N. D. *Formicidae.*
Ch. WEBSTER, R. L., Agri. Exp. Sta., Pullman, Washington. (F. '32).
Ch. WEED, CLARENCE M., 854 Andover St., Lowell, Mass. (F. '24).
'18. Wehrle, L. P., 1130 East Helen St., Tucson, Arizona. *Coccidae, Aphididae.*
'17. Weigel, C. A., Bureau Ent. and Plant Quarantine, Beltsville, Md. *Greenhouse Insects.*
'39. Weinman, Carl J., 705 Arlington Court, Champaign, Ill. *Insecticides.*
'13. WEISS, HARRY B., 19 N. Seventh Ave., New Brunswick, N. J. (F. '37). *Ecology.*
'12. WELCH, P. S., Dept. Zool., University Mich., Ann Arbor, Mich. (F. '20). *Aquatic Insects.*
'07. WELD, LEWIS H., East Falls Church, Virginia. (F. '41). *Cynipidae.*
'21. Wellhouse, Walter H., Dept. Ent., Iowa St. College, Ames, Iowa.
'36. Wells, R. W., P. O. Box 208, Dallas, Texas. *Gasterophilus, Hypoderma.*
'40. Wenger, Otto E., Dept. of Ent., Kansas State College, Manhattan, Kans.
'39. Wenzel, Rupert L., Field Museum Nat. Hist., Burnham Park, Chicago, Ill. *Histeridae.*
'36. West, A. S., Jr., Dept. of Forest Entomology, University of New Brunswick, Fredericton, New Brunswick, Canada. *Buprestidae.*
'41. West, Wm. R., Box 142, State College, Mississippi.
'41. Weymarn, Michael A., 2086 O'Farrell St., San Francisco, Calif.
'39. Whall, Harry H., Mt. Hope Cemetery, Jackson Ave., Hastings-on-Hudson, N. Y.
'18. Whedon, A. D., 1145 Third St., N., Fargo, North Dakota. *Odonata.*
'22. WHEELER, GEO. C., Univ. Station, Grand Forks, N. Dakota. (F. '40). *Formicidae, Eucharidae.*
'32. Whitcomb, W. D., 240 Beaver St., Mass. St. College Exp. Sta., Waltham, Mass.
'29. Wilbur, D. A., K. S. C., Manhattan, Kansas. *Homoptera, Cicadellidae.*
'24. WILCOX, JOSEPH, P. O. Box 287, Alhambra, Calif. (F. '41). *Asilidae.*
'35. Wild, William, 249 Walnut St., East Aurora, N. Y. *Microlepidoptera.*
'36. Wilkes, A., Dominion Parasite Lab., Belleville, Ontario, Canada.
'29. Will, Homer C., Juniata College, Huntington, Pa. *Tenthredinoidea.*

'38. Willemse, C., Eygelshovan, Z. L., Holland. *Orthoptera.*
'14. WILLIAMS, C. B., Rothamsted Exp. Station, Harpenden, Herts, England. (F. '30). *Migrations of Insects.*
'38. Williams, J. L., Box 72, Lincoln Univ., Pa. *Lepidoptera.*
'40. Williams, Roger W., 228 Dryden Road, Ithaca, N. Y.
'23. Wilson, C. C., P. O. Box 1857, Sacramento, Calif. *Orthoptera.*
'39. Wilson, Charles S., Bur. Ent. & Pl. Quar., National Research Center, Beltsville, Md. *Insect Physiology.*
'33. Wilson, Edward H., Denmark, Maine.
'25. Wilson, F. H., Dept. Zool., Tulane Univ., New Orleans, La. *Mallophaga.*
Ch. Wilson, Harley F., Dept. Econ. Ent., King Hall, Univ. of Wisconsin, Madison, Wis. *Aphididae.*
'30. Wilson, John W., Everglades Exp. Station, Belle Glade, Fla. *Economic Entomology.*
'28. Windsor, Margaret, 772 Santa Ynez, Stanford University, Calif. *Stratiomyiidae.*
'37. Wing, Merle W., Div. of Entomology, Univ. Farm, St. Paul, Minn. *Formicidae.*
'41. Wirth, Willis W., Biol. Dept., Louisiana Polytechnic Institute, Ruston, La. *Culicidae, Reduviidae.*
Ch. *Wirtner, M., 741 Railroad St., Johnstown, Pa. *Hemiptera.*
'27. Wisecup, C. B., Bureau of Ent. & Pl. Quar., Sanford, Fla. *Insecticides.*
Ch. WOGLUM, R. S., Box 5030, Metropolitan Station, Los Angeles, Calif. (F. '39).
'31. Woke, P. A., 6126 54th Ave., Riverdale, Md. *Culicidae.*
'34. Wolfenbarger, D. Otis, 8 Whippany Road, Morristown, N. J. *Economic Entomology.*
'14. Wood, W. B., 4620 Butterworth Pl., N. W., Washington, D. C.
'37. Woodbury, Elton N., 223 E. Hartswick Ave., State College, Pa. *Insecticides.*
'25. WOODRUFF, L. C., Dept. Ent., Univ. of Kansas, Lawrence, Kans. (F. '35). *Insect Physiology.*
'22. Worthley, H. N., 12 Frear Laboratory, Pennsylvania State College, State College, Pa. *Insecticides.*
'28. Wray, David L., Jr., Dept. of Agriculture, Raleigh, N. C.
'41. Wright, Gilbert, Illinois State Museum, Springfield, Illinois.
'39. Wright, Mike, 4427 Bienville St., New Orleans, La. *Odonata.*

'31. YEAGER, J. F., Beltsville Center, Beltsville, Md. (F. '37). *Physiology.*
'28. Young, Hiram C., Box 132, Florala, Alabama. *Cotton Insects.*

'21. Zerny, Hans, Burgring 7, Wien I, Austria. *Heterocera.*
'07. ZETEK, JAMES, Drawer C, Balboa, Canal Zone. (F. '39). *Trypetidae.*
'41. Zimmerman, Elwood C., Bishop Museum, Honolulu, T. H.
'38. Zimmern, Alfred, 5007 Lindsley Ave., Dallas, Texas. *Isoptera.*

Total Membership, 943. Fellows, 228. Honorary Fellows, 9.

It is interesting to note that there are 71 Charter Members and 39 Life Members.

ANNALS

OF

The Entomological Society of America

Volume XXXV MARCH, 1942 No. 1

CONSERVATION OF SCHOLARLY JOURNALS

By

THE COMMITTEE ON AID TO LIBRARIES IN WAR AREAS,
Rush Rhees Library, University of Rochester,
Rochester, New York

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the co-operation of *subscribers to this journal* in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to WAYNE M. HARTWELL, Executive Assistant to the Committee on Aid to Libraries in War Areas, *Rush Rhees Library*, *University of Rochester*, *Rochester*, *New York*.

NEW SPECIES OF THE GENUS AMPHOROPHORA

(Hemiptera: Aphididae)

E. O. Essig,
University of California, Berkeley

The genus *Amphorophora* appears to be rich in species in North America and especially along the Pacific Coast. My studies so far indicate that many of these may now be undergoing speciation for there are a number that appear to graduate from what seems to be an obviously distinct species at one end of the chain to an equally distinct species on the other with intermediates between the two. Such a complex seems to exist in two or more species living on ferns. These have presented so many difficulties that I have been compelled to postpone drawing up descriptions of them until a more careful study is made of their biology and distribution. A number of other species very closely related to some of those described herein must also await further study for the same reasons.

The seven species described represent those which seem to be sufficiently distinct to warrant publication at this time. A single eastern species is included in the study.

Amphorophora bartholomewi Essig, n. sp.

(Fig. 1)

This very large species was collected by Dr. P. S. Bartholomew on twinberry, *Lonicera involucrata* (Richardson), Banks, at Clam Beach, Little River, Humboldt County, California, July 15, 1931, and on the same host at Lake Center Camp, Lakes Basin, Plumas County, California, on August 9, 1931. Only apterous forms were taken.

Apterous viviparous female.—Length 3.8–4.3 mm., width 1.5–1.7 mm.; length of antennae 4.6–4.8 mm., segment III 0.9–1.2 mm., IV 0.8–1.0 mm., VI 1.8–2.0 mm.

Color bright green throughout with a large, oval paler green area around the base of each cornicle, the two of which may coalesce, and usually with a paler dorsal median line. Without any apparent dusky or glandular areas on the body and with appendages concolorous with the body or only tips of the antennae dusky. Nymphs pale green to almost whitish.

Hairs fairly long, rather fine and generally distributed over the body and appendages; on the hind tibiae they are shortest at the apices.

Antennae longer than the body; III longer than the cornicles and subequal with VI; IV and V subequal and only slightly shorter than III; VI nearly twice as long as III. *Secondary sensoria* varying in number from 9–15, circular, very small, tuberculate, scattered or in a row on the basal one-half or two-thirds of III. *Rostrum* noticeably wide and blunt; with numerous fine hairs and extending nearly to the 3rd coxae. The apical segments vary somewhat in width and appear narrower in the specimens taken in the Sierra Nevada Mountains. *Cornicles* very long, nearly twice the length of the cauda; wide at base and slightly swollen just before the conspicuously constricted and reticulated apical one-fourth; flange distinct and almost or quite equals the diameter of the swollen area; length 1.0–1.2 mm. In some specimens they appear faintly dusky. *Cauda* conspicuously broad, parallel-sided and rounded apically; rough, and with many scattered hairs or spines—8 or 9 lateral pairs and 4 or 5 median ones; length 0.6–0.7 mm.; appears to be concolorous with the body or only faintly dusky.

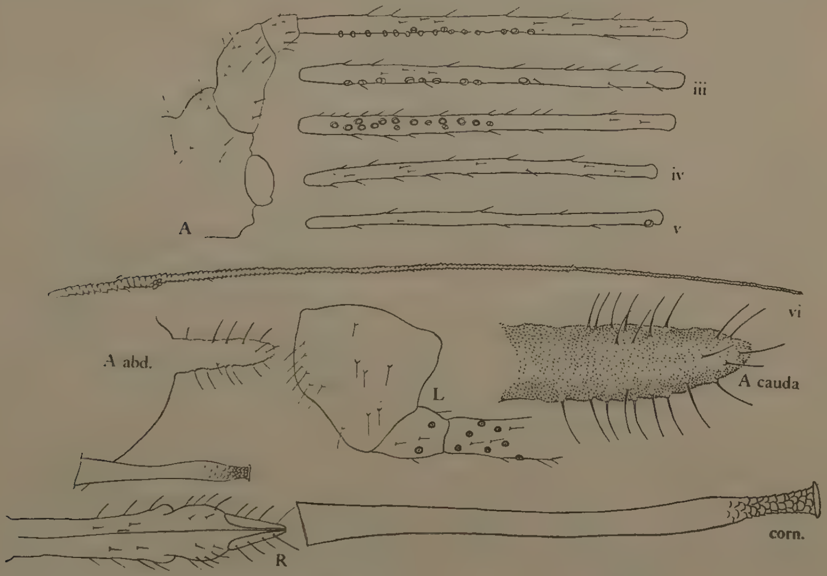


Fig. 1. *Amphorophora bartholomewi* n. sp. Apterous viviparous female. A, head and antennae; L, base of hind leg showing sensoria; R, rostrum.

This species has been described from 15 adults and 3 nymphs collected in Humboldt County (no. 351), cleared and mounted on 9 slides and 9 adults and 7 nymphs collected in Plumas County, California, (no. 491), which were preserved in alcohol and cleared, stained, and mounted on 4 slides in January, 1941. A single apterous individual is designated as the type and the others as paratypes. Paratypes of this and the others herein described have been deposited in the collection of the Bureau of Entomology and Plant Quarantine, Washington, D. C.

This new species might be confused with *Amphorophora maxima* Mason, a single winged specimen of which was taken on salmonberry, *Rubus spectabiles* Pursh., in California. It is larger than Mason's species, has the cornicles more constricted apically and shorter than segment III, and has a much larger cauda which has many more hairs and is not constricted basally. It is named for its collector.

Amphorophora occidentalis Essig n. sp.

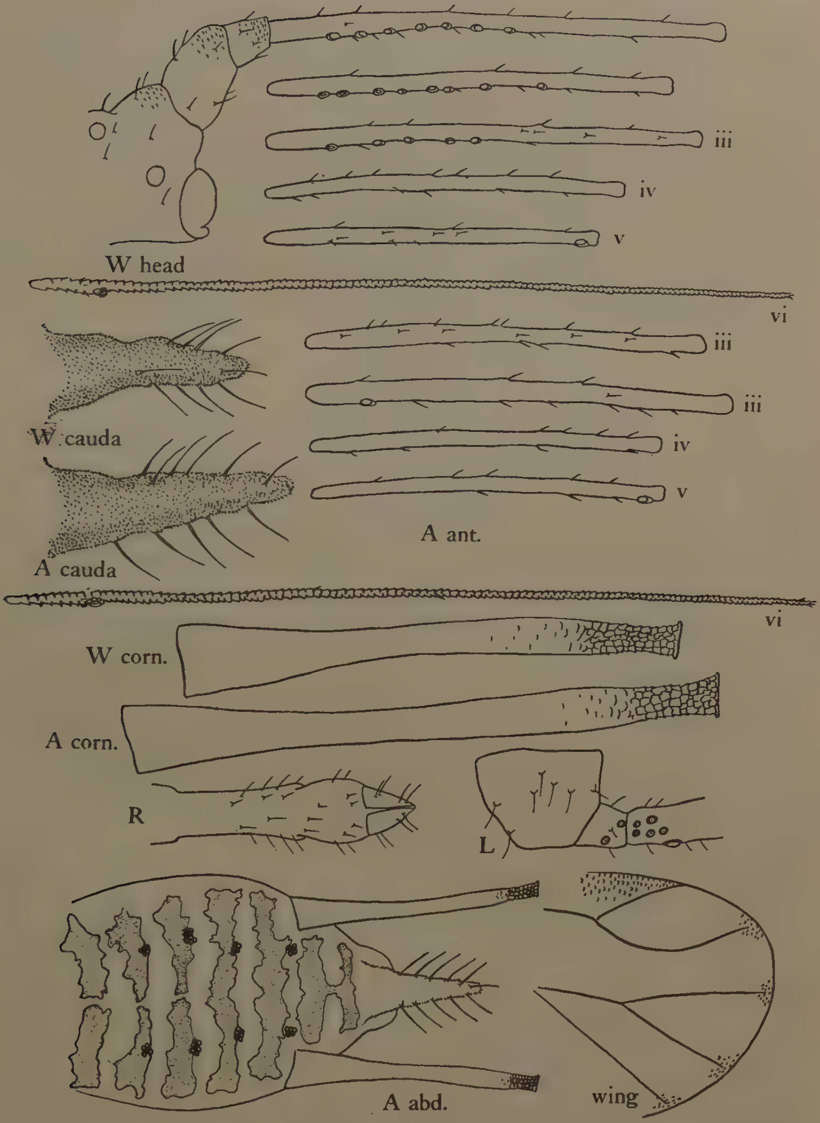
(Fig. 2)

A very pale yellow or almost white species living sparingly on the undersides of the mature leaves of the bitter cherry, *Prunus emarginata* (Dougl.) Walk., growing under larger trees on the campus of the University of Washington, Seattle, Washington, and collected by the writer on June 20, 1940.

Coloration.—The specimens taken by the writer at Seattle were all very pale yellow or almost whitish, but stained specimens reveal dorsal transverse thickenings similar to those illustrated. It is possible that these stained areas may appear somewhat dusky in individuals exposed to greater intensities of light.

Winged viviparous female.—Length 3.5 mm.; width 1.2 mm.; length of antennae 4 mm., III 0.8–0.9 mm., VI 1.5 mm. Stained specimens show thickened lateral circular areas and two sub-median rows of smaller glandular areas. Frontal tubercules prominent. Hairs rather short and simple; 3–4 spines and a small tubercle in each of the lateral thickenings. *Antennae* longer than the body; III much shorter than VI and with from 5 to 7 circular sensoria in a row over or slightly beyond the basal half. *Rostrum* short and blunt, extending to 2nd coxae. Wing veins with faintly clouded borders and apices. *Cornicles* concolorous with body or dusky posteriorly; widest basally and swollen in the apical one-third; constricted and reticulated apically; extending beyond the tip of the cauda; slightly or considerably longer than antennal segment III and more than twice as long as the cauda; length 1 mm. *Cauda* somewhat sharply triangular and pointed; faintly emarginated or constricted; rough; with 4 pairs of lateral and 2 subdorsal hairs; length 0.3–0.4 mm.

Apterous viviparous female.—Length 3.5–3.8 mm.; width 1.5 mm.; length of antennae 4 mm., III 0.7 mm., VI 1.6 mm. Stained specimens show dark irregular and broken cross-bands on the abdomen, in which are two longitudinal rows of glandular areas. *Antennae* noticeably slender; segment III usually without any or rarely with 1 or 2 circular secondary sensoria near the base. *Rostrum* extends to 2nd coxae. *Cornicles* may be dusky near the middle or throughout the apical half;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wing

Fig. 2. *Amphorophora occidentalis* n. sp.

similar to those in the alates but larger; length 1.2 mm. *Cauda* 0.4–0.5 mm. in length.

This species is close to *Amphorophora nervata* (Gillette) but differs in having relatively shorter and more reticulated cornicles; fewer sensoria on III of the alates; and a shorter and blunter rostrum.

The description has been made from 15 adult alates, 64 adult apterae, and 2 nymphs. Of these, 6 alates, 25 apterae and 1 nymph are simply cleared and 9 alates, 39 apterae and 1 nymph are also stained. All are mounted on 13 slides. One stained winged viviparous female is designated as the type and all others are designated as paratypes.

Amphorophora patchiae Essig n. sp.

(Fig. 3)

This bright green rather slender species was collected along U. S. Highway 2, near Littleton, New Hampshire, by the writer on June 15, 1937. It occurred in dense colonies on the apical growths of what was determined to be horseweed or butterweed, *Erigeron canadensis* Linn., growing along the roadside. At the time I thought that the species was possibly a well-known one and did not collect as large a series as I should now like to have. Specimens sent to several specialists were thought to be undescribed.

Color bright green throughout with the usual dusky or dark head and thoracic regions of the alates. The antennae, legs, cornicles, and cauda may appear wholly green or may be partically dusky and dusky areas show on the abdomen of cleared and stained winged specimens.

Winged viviparous female.—Length (from frons to tip of cauda) 2.7 mm.; width 1.0 mm.; length of antenna 3.0 mm.; length of fore wing 3.5 mm. Head, antennae, femora, bases of tibiae, and other parts of body with very small blunt or knobbed setae; other body hairs slender. *Antennae* with from 14 to 19 circular or semi-circular secondary sensoria of variable sizes arranged irregularly or evenly in a row over much of the length of III. These sensoria are sometimes tuberculate and angularly exposed. *Rostrum* short, extending to or slightly beyond the 1st coxae; with few fine hairs. Small prothoracic tubercle present. Tibia with short stout spines near apices. Wing veins distinct and with narrow clouded margins. Abdomen, when cleared, shows very fine reticulations, and slender hairs. *Cornicles* imbricated, often widest at base, swollen posteriorly, and narrowed and reticulated apically as illustrated; length 0.6 to 0.7 mm. *Cauda* rather blunt, with 3 or 4 pairs of lateral spines and 1 nearly apical spine; length 0.3 to 0.4 mm.

Apterous viviparous female.—Length of body 2.7; width 1.1 mm.; length of antennae 3.1 mm. Epidermis wrinkled in cleared specimens.

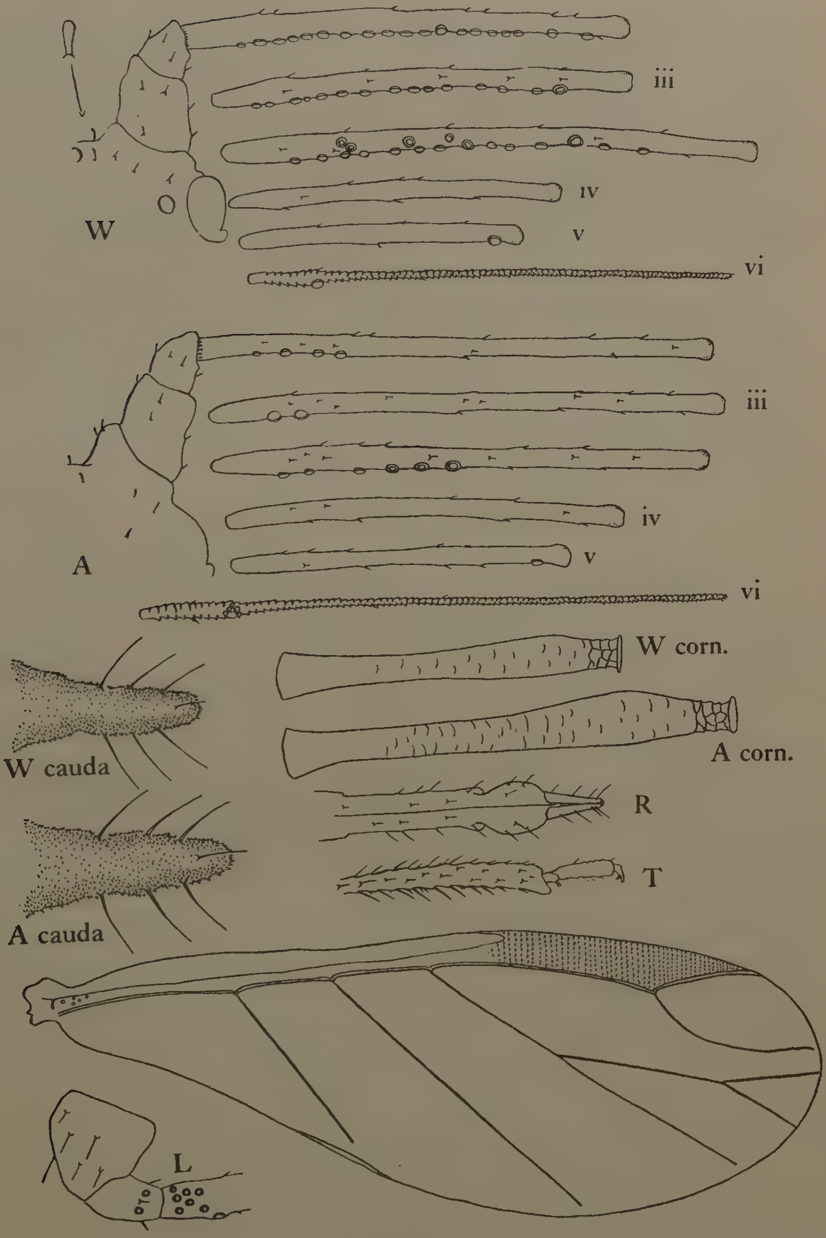
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Fig. 3. *Amphorophora patchiae* n. sp.

Body with short, knobbed setae and fine hair-like spines, the latter arranged in small transverse groups on the abdomen. *Antennal segment III* with from 1 to 7, usually 2 or 3, circular secondary sensoria which are variable in size. *Rostrum* extending to the 2nd coxae. *Cornicles* imbricated throughout, similar in shape to those of the alates; length 0.7 mm. *Cauda* 0.3 mm. long.

In the key to the *Amphorophora* by Mason (1940) this species comes near to *A. corylina* (Davidson), but differs from it in having fewer sensoria on segment III of the alate and in having quite differently shaped cornicles and cauda.

This species is dedicated to the eminent aphidologist, Dr. Edith M. Patch.

These descriptions were made from 18 alate and 57 apterous females mounted on 14 slides. Some of the specimens were considerably disfigured in mounting. One winged specimen is designated as a type and the remainder as paratypes.

Amphorophora phacelia Essig n. sp.

(Fig. 4)

A relatively small and slender green species abundant on the undersides of the leaves of *Phacelia* sp. growing in the bed of Bull Creek, near Dyerville, Humboldt County, California. Collected and mounted by Paul S. Bartholomew, July 10, 1931 (no. 329).

Color. According to Bartholomew the apterous forms are green to yellowish-green with a brighter green spot between the cornicles and a dorsal longitudinal patch similarly colored anterior to this spot; the alates are green with the usually dusky head and thorax and the apices of the antennal segments III-VI, the leg segments, tarsi, and cornicles dusky.

Winged viviparous female.—Length 2.8 mm.; width 1.0–1.2 mm.; length of antennae 3.2 mm., III 0.7 mm., VI 1.4 mm.; length of fore wing 3.4 mm. Body hairs rather long and fine; those on the dorsum of the abdomen scattered and those on the venter arranged in 2 rows or in 1 row posteriorly; those on the tibiae are the longest and stoutest. *Antennae* long and noticeably slender; III about half as long as VI and with from 13 to 15 circular sensoria of variable size over most of the length as illustrated. *Rostrum* long and slender; extending nearly to 3rd coxae or beyond; with segment 5 minute, 4 slenderer and nearly twice the length of 3; with many hairs. *Wings* with well-pigmented veins. *Cornicles* slender, somewhat recurved, only slightly swollen beyond the middle; imbricated; constricted and reticulated at the apex and with conspicuous flange; extending to the tip of the cauda; length 0.65 to 0.80 mm. *Cauda* rough; tapering almost to a point and only faintly constricted near the middle, with 3 pairs of lateral and 2 subdorsal hairs; length 0.2–0.3 mm.

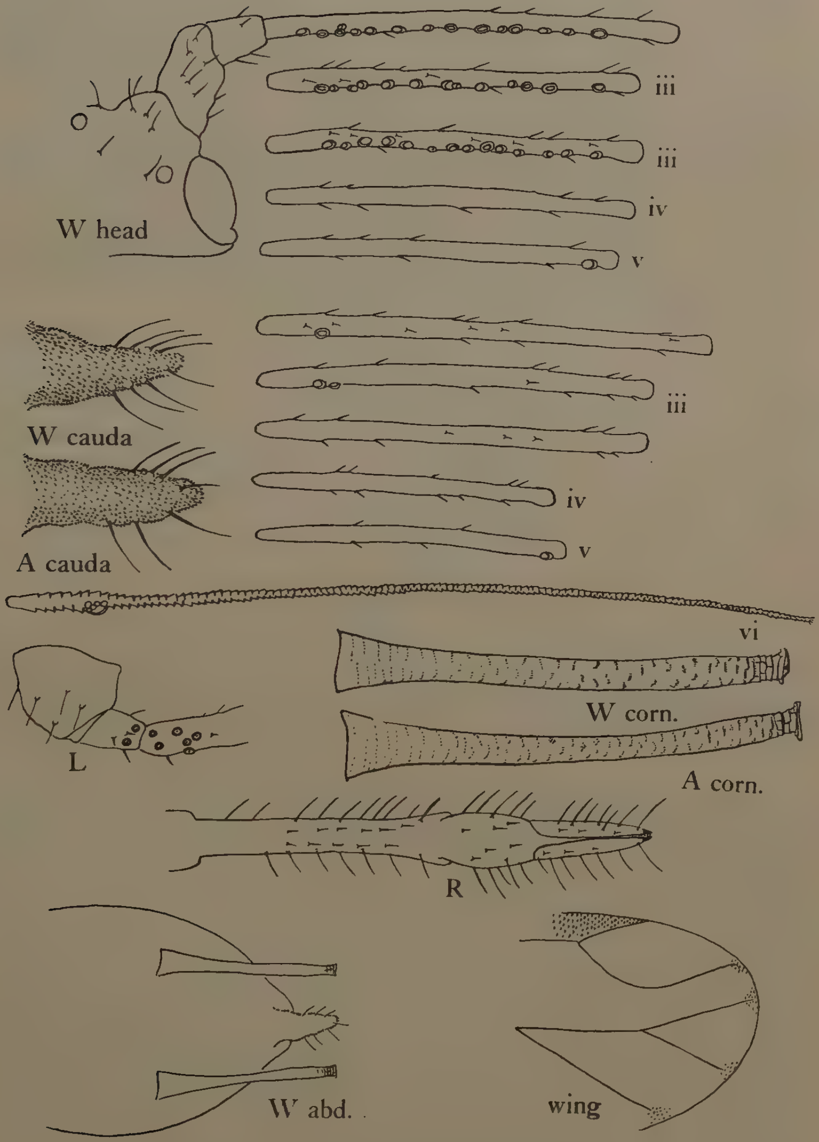
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Fig. 4. *Amphorophora phacelia* n. sp.

Apterous viviparous female.—Length 2.5–2.7 mm.; width 1.2–1.3 mm.; length of antennae 3.5 mm., III 0.7 mm., VI 1.4 mm. Epidermis wrinked and finely imbricated. Hairs fine and often rather long and curved, simple. *Antennal segment III* with 1 or 2 circular secondary sensoria at the base. *Rostrum* extending beyond 3rd coxae. *Cornicles* same as in alate forms; 0.70 to 0.75 mm. *Cauda* somewhat rounded apically as illustrated; length 0.3 mm.

This species is closely related to *Amphorophora nervata* (Gillette) but differs in having the antennal segment VI much longer, the cornicles not so swollen, fewer sensoria on III of the alates and usually one or two on III of the apterae, the cauda somewhat shorter in proportion to its length, and the terminal segments of the rostrum longer and narrower.

The description has been drawn from 20 adult apterous, 9 winged, and 3 nymphal specimens stained and mounted on 7 slides. A single winged individual (on a slide with 3 others) has been designated as the type and all the others as paratypes. These specimens were preserved in alcohol from the date of collection, 1931, until cleared in 1941, which accounts, in part, for their imperfect condition.

Amphorophora tolmiea Essig n. sp.

(Fig. 5)

This medium-sized green species was taken by the author on the leaves of the saxifrage, *Tolmiea menziesii* (Pursh) T. & G., at Otis, Oregon, June 11, 1938.

Color green, the winged forms with the usual dusky or black head and thorax, and the antennae, legs, cornicles, cauda and the circular lateral abdominal areas, two subdorsal rows of glandular areas—those near the middle largest, and two transverse dorsal bands before the cauda dusky or black. In the apterae the head is faintly dusky; antennal segments I, II, and base of III dusky, the remainder black; legs, rostrum, cornicles, cauda, and posterior region of the abdomen dusky. The reticulated areas of the cornicles are black.

Winged viviparous female.—Length 3 mm.; width 1 mm.; length of antennae 3.2 mm., III 0.7 mm., VI 0.14 mm., length of fore wing 4 mm. *Frontal tubercles* distinct. Hairs small and simple; those on tibiae longer than the diameter of that leg segment. Antennal segment I gibbous; I and II imbricated on the inner surfaces; III–VI quite slender, with few short hairs; III with 5–6 circular secondary sensoria in a row over a part or the full length. *Rostrum* as illustrated; with a considerable number of hairs; extending to the 2nd coxae. *Wings* with well-defined veins with faintly cloudy narrow borders. *Cornicles* dusky or black throughout, strongly imbricated, slightly swollen beyond the middle, reticulated and constricted apically, and with an unusually large flange;

not extending to tip of cauda; slightly shorter than III and nearly twice the length of the cauda; length 0.5–0.65 mm. *Cauda* black; rather short and rounded at tip; emarginate and with slight constriction before the middle; rough; with 3 or 4 pairs of lateral hairs and at least one sub-apical hair; length 0.3–0.35 mm.

Apterous viviparous female.—Length 3 mm.; width 1.3 mm.; length of antennae 3 mm., III 0.6 mm., VI 1.2–1.4 mm. *Hairs* small and simple. *Frontal tubercles* much as in the alates. *Antennae* slender and with few small setae; III usually without secondary sensoria, rarely with but one near the base. *Hind tibiae* strongly recurved, hairs or spines longer than diameter of this segment. *Cornicles* dusky with bases paler and the reticulated area black; length 0.65–0.70 mm. *Cauda* dusky, 0.3–0.4 mm. long.

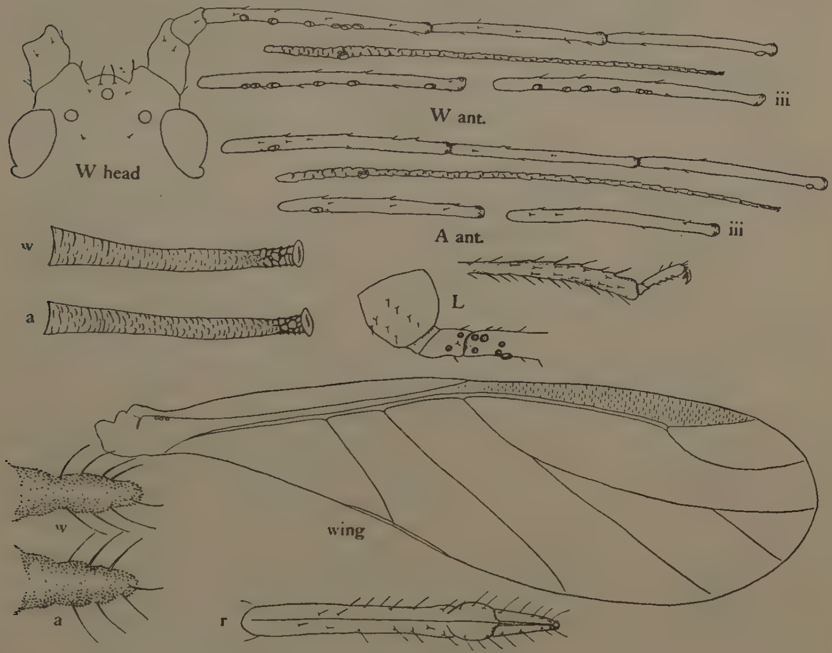

Fig. 5. *Amphorophora tolmiea* n. sp.

This species does not key out in any of the tables. It is at once separated from all related species by the few sensoria on segment III of the winged forms.

The description has been made from 16 apterous and 2 winged viviparous females mounted on 6 slides. One of the two winged specimens (upper on slide) has been designated as the type and all the others as paratypes.

Amphorophora tuberculaceps Essig n. sp.

(Fig. 6)

This very large species is distinguished by a pair of small cone-like tubercles on the vertex of the head between the compound eyes. These tubercles are more conspicuous on the alate than on the apterous forms. The specimens were collected by sweeping "herbs" at Boyer, Oregon, and forwarded to me for determination by Prof. James A. Macnab, Linfield College, McMinnville, Oregon. Four lots were taken (by J. C. D.) and marked as follows: E-64, June 24, 1938; E-68, July 21, 1938; E-75, July 19, 1938; E-77, June 24, 1938. No other host than "herb" was given.

Color. The color is not indicated but is probably green or possibly green or pinkish. The mounted and stained apterous forms show no pigmentation of any kind. The alates are definitely pigmented and have dusky abdominal markings as indicated by the drawing. Portions of the head and thorax are black and the appendages are faintly dusky.

Alate viviparous female.—Length 3.5 mm.; width (mounted specimens) 1.3–1.5 mm.; length of antennae 4.2 mm.; III 0.8, VI 1.6 mm.; length of wing 5 mm. *Setae* quite small and pointed; arranged on the abdomen in considerable numbers. *Head* with a pair of small tubercles on the vertex between the eyes and what also appears to be a second pair of smaller and more inconspicuous tubercles also present. *Frontal tubercles* prominent and armed with simple hairs. *Antennae* about as long as the body; III with 7 or 8 circular secondary sensoria arranged in a row on the basal half as illustrated. *Rostrum* short, rather blunt, and extending nearly to the 2nd coxae. *Abdomen* with dusky lateral tubercles and spined areas and with broken transverse dusky and glandular areas as illustrated. *Wings* large, 5 mm. long. *Cornicles* faintly imbricated; thickened basally and swollen throughout the basal part of the apical half with reticulated apical constriction and a well-defined flange as shown; 0.8 mm. long or same length as antennal segment III. *Cauda* large, paddle-shaped and with a slight constriction beyond the base; with 3 or 4 pairs of prominent lateral and 2 or more subdorsal hairs.

Apterous viviparous female.—Large and robust; length 3.5–4.3 mm. (from front to tip of cauda); width (mounted) 1.5–2.0 mm.; length of antennae 3.5–4.0 mm., III 0.8 mm., VI 1.5 mm. Dorsal head tubercles difficult to see on mounted specimens; frontal tubercles large and prominent. Body with small, pointed setae; epidermis finely reticulated and wrinkled. *Hairs* on head and legs quite long, those on the coxae and anal plate long and fine and those on the apical parts of the tibiae spine-like. *Antennal segment III* with 1 to 4 circular secondary sensoria near the base. *Rostrum* short and extending to the 2nd coxae. *Cornicles* finely imbricated; similar in form to those of the alates; not extending quite to the tip of the cauda; length 0.8 to 1.0 mm., or about equal in length to antennal segment III and not quite twice the length of the cauda. *Cauda* large, coarsely beset with microtrichia; paddle-shaped,

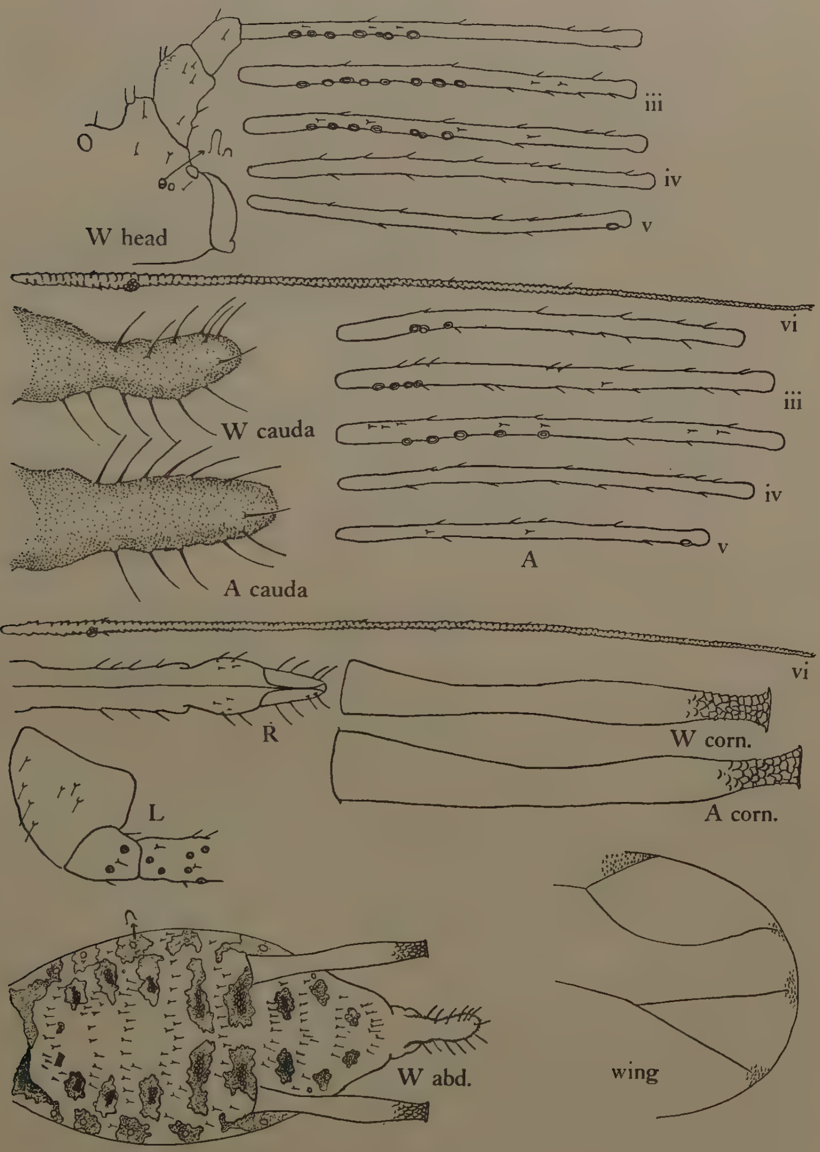
W head
iii
iv
v
vi
W cauda
A cauda
iii
iv
v
A
vi
R
W corn.
A corn.
L
W abd.
wing

Fig. 6. *Amphorophora tuberculaceps* n. sp.

rounded apically, and only slightly constricted before the middle; with about 11 large spines; length 0.5 to 0.6 mm.

In view of the fact that all of the specimens were collected by sweeping, that the host plants are unknown, that they represent four different lots, and that all were preserved in alcohol, it is barely possible that more than a single species is involved. However because they all have in common the dorsal head tubercles, the same general type and size of antennae, rostrum, cornicles, and cauda indicate their specific relationships.

This species is also to be separated from the closely related *Amphorophora bartholomewi* n sp. by the fewer sensoria on III of the apterae, by the constricted cauda and the relatively shorter cornicles. It may be distinguished from *A. patchiae* n. sp. by fewer sensoria on the segment III of the alates, the much longer antennal spur, and the longer and pointed hairs.

The description has been drawn from 20 nymphs, 31 mature apterous females, and 2 alates mounted on 10 slides. All excepting the 2 alates were stained with acid magenta red. Several of the apterous forms are without legs and antennae. A single alate has been designated as the type and all others as paratypes.

Amphorophora urtica Essig n. sp.

(Fig. 7)

A large and robust species infesting the undersides of the larger leaves of nettle, *Urtica gracilis* Ait. var. *holoserica* Jepson, in the San Francisco Bay region, California.

Color. The alate forms are black and dark mahogany-red or brownish, with a row of 4 somewhat circular dusky areas along the margins of the abdomen and with one or more largely irregular dusky areas behind the cornicles and a few dark spots on the dorsum. The antennae, most of the legs, cornicles, and cauda are dusky. The apterous forms are somewhat grayish dark red with purplish reflections, with numerous small irregular dark markings on the dorsum, and the antennae, cornicles, and cauda dusky.

Winged apterous female.—Length 3.2 mm.; width 1.7 mm.; length of antennae 3.4 mm.; length of fore wing 3.5 mm. With short blunt or capitate setae on the head, antennae, and various other parts of the body. Body spines or hairs rather short; those on the undersides of the tibiae stout. Cleared specimens show dark glandular areas on the abdomen. A short prothoracic tubercle is present and a single small tubercle and several blunt spines arise from each of the lateral dark abdominal patches. *Antennal segment III* with from 9 to 19 small to medium-sized circular or semicircular, slightly tuberculate secondary sensoria arranged in a row or nearly so. The relative lengths of the segments are illustrated. *Rostrum* short, extending beyond the middle coxae; with many short hairs. *Wings* with well-defined veins which have faintly dusky borders. *Cornicles* wide at base swollen beyond the

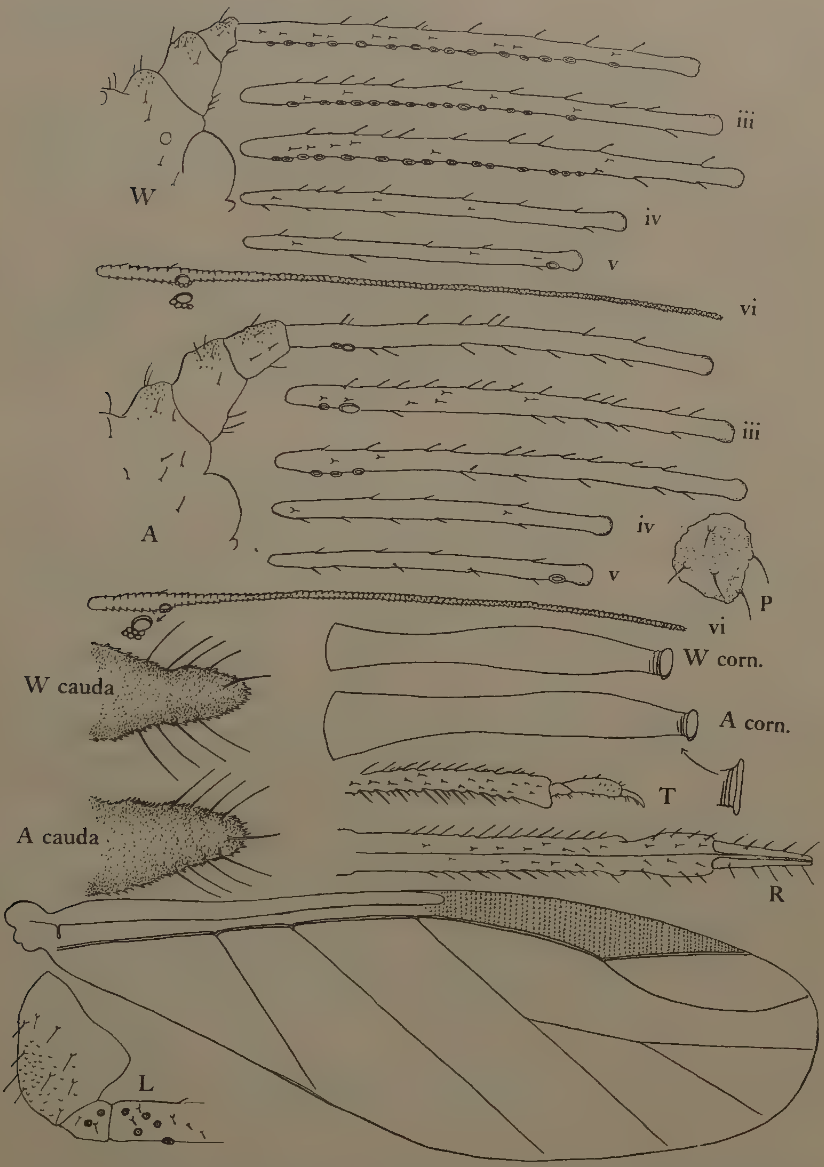
W
iii
iv
v
vi
A
iii
iv
v
vi
P
W cauda
W corn.
A corn.
A cauda
T
R
L

Fig. 7. *Amphorophora urtica* n. sp. A, apterous and W, winged viviparous females; L, base of leg; P, pigmented lateral and abdominal area; R, rostrum; T, tip of hind tarsus.

middle as illustrated; with a few encircling apical imbrications and without reticulations; flange small; length 0.6 to 0.7 mm. *Cauda* relatively short and blunt, with 4 pairs of lateral hairs and a median apical one; length 0.35 mm.

Apterous viviparous female.—Length 3.2 mm.; width 1.7 mm.; length of antennae 3.4 mm. Distinctly broad and robust; the surface of cleared mounted specimens finely reticulated, with small dark areas near the bases of the short blunt hairs and dark glandular groups. *Rostrum* extends beyond the 3rd coxae. *Cornicles* 0.7 to 0.8 mm. and *cauda* 0.35 to 0.40 mm. in length.

This species appears to be closely related to what may be a composite species described as *Amphorophora cicutae* by Shinji in 1917 from water hemlock, *Cicuta californica* Gray, on the campus of the University of California, where this new species also occurs. The differences between the two may be summarized as follows:

	A. urtica	*A. cicutae*
Host	Nettle	Water hemlock.
Color	Dark red to grayish	Light to pale green.
Secondary sensoria on III of apterae	One or two	None to fewer than in alates.
Length of antennal segment III of apterae	As long or longer than in alates	Much shorter than in alates in Shinji's drawing.

The drawing by Shinji showing the comparative lengths of antennal segment III in the alate and apterous forms indicate that he either had an immature specimen of the apterous form or a different species. Since none of his described specimens are available and we have not definitely recovered his species, this point cannot be cleared up at the present time.

This species has been described from a lot consisting of 23 alate and 110 apterous viviparous females mounted on 33 slides and collected by Paul S. Bartholomew on nettle at Stanford University, California, on December 12, 1932, and January 1, 1933, all from the Bartholomew Collection of Aphididae acquired by the writer in November, 1937. A single slide containing an immature specimen and a mature alate collected on nettle on the campus, University of California, was included. I have also seen a considerable amount of material collected at the latter place by my students. A single-winged individual is designated as the type and all other specimens as paratypes.

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NEW DOLICHOPODIDAE OF WESTERN NORTH AMERICA[1]

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The following report deals with four apparently undescribed species of long-legged flies from localities in western North America.

Dolichopus sporadicum n. sp.

(Figs. 1, 10 and 12)

Male.—Length, 4 mm.; of wing, 3.8 mm. Face wide, rather short, brownish yellow. Front metallic green, narrowly brownish along orbits and above base of antennae. Antennae (fig. 10) yellow, except for apical three-fourths of third segment, which is dark brown. Palpi yellow with black hairs. Lateral and inferior orbital cilia yellow, about eight of the upper cilia black.

Thorax green with coppery reflections, the dorsum lightly dusted with pollen which appears yellowish when viewed from in front; pleurae dulled with white pollen. Abdomen metallic green, the incisures narrowly blackish; lateral and ventral portions whitish pollinose. Hypopygium small, black, dusted with white pollen, its lamellae (fig. 12) extremely small, somewhat oval, scarcely jagged at apex, brownish but shading into a broad blackish apical border.

Fore coxae yellow, scarcely blackish at extreme base, the anterior surfaces clothed with small black hairs; the usual black bristles at tip. Middle and hind coxae black, narrowly yellow at tips. Femora and tibiae yellow. Middle and hind femora each with one preapical bristle, the latter without cilia below. Posterior tibiae black at apex, not or scarcely enlarged at tip. Fore tarsi blackened from the tip of first joint; middle and hind tarsi wholly black. Joints of fore tarsi as 11–7–5–4–4; of middle tarsi as 15–7–5 (last two joints missing); of hind tarsi as 15–15–10–7–6. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 1) gray; costa without enlargement at tip of first vein; fourth vein bent before its middle; anal angle evenly rounded, rather prominent.

Described from one male taken at Manila, Utah, July 17, 1940, by G. F. Knowlton and F. C. Harmston. Type in Utah Agricultural Experiment Station insect collection.

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[1] Contribution from the Department of Entomology, Utah Agricultural Experiment Station.

[2] Graduate assistant and research associate professor, respectively.

Taxonomy.—Dolichopus sporadicum n. sp. traces to couplet 226, page 16, of the Van Duzee and Curran key to males of Nearctic Dolichopus (American Museum Novitate No. 683), where it would form a third alternative as follows: Middle tibiae wholly yellow, without silvery pollen or black line; hind tibiae black only at extreme tip. The relationship of *sporadicum* n. sp. is perhaps nearest *plumipes* Scopoli, which it closely resembles in general external appearance; however, it is readily separated from the latter species by the absence of a lateral fringe on the middle basitarsi and because it possesses extremely small hypopygial lamellae.

Dolichopus nomadus n. sp.

(Figs. 2–4, 11)

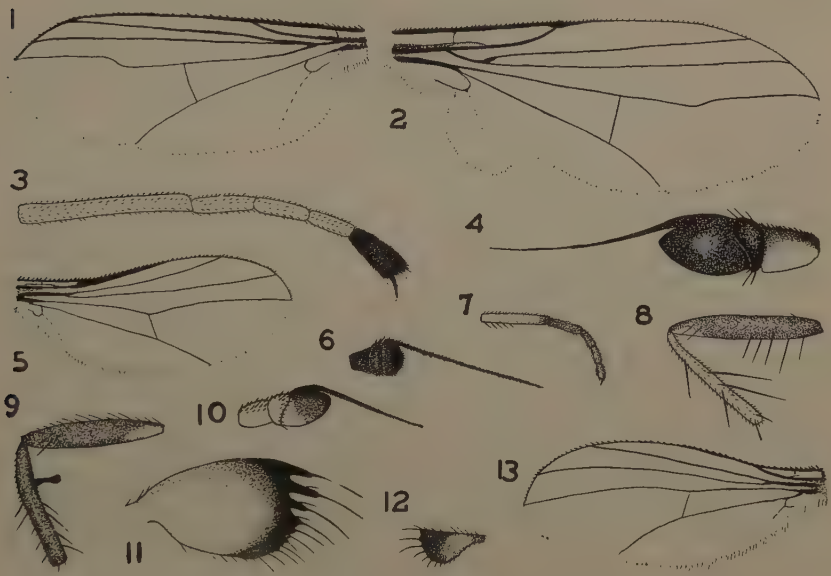
Male.—Length, 4.8 mm.; of wing, 4.5 mm. Face of moderate width, covered with dense, yellowish-brown pollen; palpi concolorous with face, their surfaces with many short, black hairs; front deep violet, shining, with a greenish luster along the orbits. Antennae (fig. 4) black except first joint yellow on lower half; the third joint rather large, longer than wide, obtusely pointed at tip. Orbital cilia wholly black.

Thorax dark green, dusted with gray pollen which hardly hides the coppery reflections; pleurae concolorous with dorsum, yet their surfaces dulled with thick gray pollen which completely obscures the ground color. Abdomen dark green, shining, somewhat pollinose along lateral margins; the first segment, together with incisures of the other segments more blackish, with coppery reflections. Hypopygium black with thick white pollen, its lamellae (fig. 11) yellowish, of moderate size, with broad black border, deeply jagged at tip and fringed at apex and on upper edge with long black hairs.

Fore coxae yellow, a blackish, densely pollinose spot at base on outer surface, the anterior surface with black hairs and strong black bristles at tip; mid and hind coxae black, narrowly yellow at tip. Femora and tibiae yellow, the posterior femora blackened at tip above, the hind tibiae black on apical one-sixth, scarcely enlarged at tip. Middle and hind femora each with two preapical bristles, the posterior pair without cilia below, yet showing a row of delicate yellowish hairs approximately one-fifth as long as the width of femora; middle tibiae with one strong bristle below near apical third. Fore tarsi (fig. 3) one and one-third times as long as their tibiae, yellow except for fifth joint, which is black and slightly compressed; the empodium large, forming a conspicuous white tip to tarsi; middle tarsi blackened from the tip of first joint, the basitarsi without a bristle above; posterior tarsi wholly black, one and one-half times the length of their tibiae; joints of fore tarsi as 15–5–5–4–5; of middle tarsi as 24–12–10–7–7; of hind tarsi as 24–22–16–10–7. Calypters and halteres yellow, the former with black cilia.

Wings (fig. 2) grayish hyaline, costa with a small knot-like enlargement at tip of first vein; last section of fourth vein bent just before its middle; hind margin of wing slightly indented at tip of fifth vein, the anal angle deeply incised midway between the tip of fifth vein and the anal angle, forming a large nearly rectangular lobe on the anal angle.

Described from one male taken at Cypress Hills, Alberta, Canada, August 10, 1939, by E. H. Strickland. Type deposited in the Canadian National Museum, Ottawa.



Dolichopus sporadicum n. sp. Male, figs. 1, 10, 12.
Dolichopus nomadus n. sp. Male, figs. 2–4, 11.
Teuchophorus utahensis n. sp Male, figs. 5–6, 8–9.
Teuchophorus diminucosta n. sp. Male, figs. 7, 13.

Taxonomy.—Dolichopus nomadus n. sp. keys to couplet 108, page 8 in the Van Duzee and Curran key to males of Nearctic Dolichopus (American Museum Novitate, No. 683); it differs, however, in having first antennal joint yellow below, but of moderate size and without strong bristles as is the case in *bruesi* V. D. The wholly black orbital cilia, large lobe at base of wing, presence of two preapical bristles on middle and hind femora, and absence of a bristle on upper surface of middle basitarsi will distinguish *nomadus* n. sp. from described species occurring in North America.

KEY TO NORTH AMERICAN TEUCHOPHORUS

The three species of *Teuchophorus* now known to occur in North America may readily be separated by the following key:

1. Costa greatly thickened at tip of first vein; this thickened area is black, tapers rapidly and ends midway between the tips of first and second veins. 2
   Costa without thickening; all coxae yellow. . . . .**diminucosta**
2. Middle and hind coxae black; all femora black except narrowly at tips, or the posterior femora may be yellowish below at extreme base. . . . .**utahensis**
   Middle and hind coxae wholly light yellow; all femora yellow, except for an infuscation on hind pair at apex on upper side. . . . .**clavigerellus**

Teuchophorus utahensis n. sp.

(Figs. 5, 6, 8 and 9)

Male.—Length, 1.2 mm.; of wing, 1.5 mm. Face moderately wide, narrowed below, covered with white pollen which is thinner on upper portion, allowing the greenish ground color to show through. Front metallic, dark blue. Antennae (fig. 6) black, the third joint short, broader than long; arista tapering, nearly four times the length of the antenna. Palpi small, dark brown, more yellowish at tips, their surface covered with pale cilia. Inferior orbital cilia white; the upper cilia are black and descend to about the middle of the eye.

Thorax dark metallic green; pleurae dusted with gray pollen. Dorsum of thorax with a concave prescutellar depression, which is rounded anteriorly. Scutellum with a single large pair of marginal bristles, inside of which is a pair of small, hair-like bristles. Abdomen metallic, dark green, laterally compressed, its surface with small black hairs, the latter appearing brown in certain lights. Hypopygium small, black, rounded behind, with a pair of small yellowish appendages which are directed backward. Calypters and halteres yellow, the former with black cilia.

Coxae black, the anterior pair yellowish on apical third and on inner surfaces nearly to their base, hair and bristles of all coxae brownish. Femora black with tips yellowish; posterior pair (fig. 9) yellow on lower basal one-fourth, possessing a comparatively large preapical bristle around which are grouped several smaller bristles; middle femora (fig. 8) with a row of about 5 bristle-like hairs at base below. Fore and middle tibiae brownish, the posterior pair (fig. 9) black, somewhat thickened, with a peculiar flattened, spur-like appendage near basal third on inner surface and several longer bristles distal to the spur. Fore and middle tarsi blackened from the tip of first joint; fore basitarsi with about five slender bristles below, which are about as long as the width of basitarsi; posterior tarsi wholly black, of plain structure. Joints of fore tarsi as 8–4–3–3–2; of middle tarsi as 8–4–3–2–2; of hind tarsi as 5–5–4–3–2.

Wings (fig. 5) large, grayish; costa with a conspicuous black enlargement beginning at the tip of first vein which tapers gradually, ending midway between the tips of first and second veins; crossvein oblique (which is characteristic of the genus) and situated slightly before the middle of wing.

Female.—Like male in general body color; differs in having legs of plain structure, without unusual bristles; the wings are shorter, broader and with more prominent anal angle.

Described from 9 males and 1 female all taken at Roosevelt, Utah, July 19, 1940, by G. F. Knowlton and F. C. Harmston. Holotype and allotype in the U. S. National Museum. Paratypes in the insect collections of Utah Agricultural Experiment Station, Ohio State University, California Academy of Sciences and University of Kansas.

Taxonomy.—Teuchophorus utahensis n. sp. may be separated from *T. clavigerellus* Wheeler and *T. diminucosta* n. sp. by possessing black middle and hind coxae, femora and hind tibiae; the above structures are yellow in the two latter species.

Teuchophorus diminucosta n. sp.

(Figs. 7 and 13)

Male.—Length, 1.2 mm.; of wing, 1.6 mm. Face narrow, especially on lower portion, short, leaving lower corners of eyes exposed, lightly dusted with silvery pollen which allows the greenish ground color to show through. Palpi small, black, their apices tending toward brown. Front metallic, green, scarcely dusted with grayish pollen. Antennae black; third joint broader than long, perceptibly pubescent; arista pubescent, about as in figure 6. Inferior orbital cilia white; the upper black cilia descend to about one half the eye height.

Thorax and abdomen green, the latter slightly darker and somewhat laterally compressed; hair and bristles of the thorax and abdomen black, except for the small hairs on the lateral and ventral portions of the abdomen; pleurae concolorous with dorsum with coppery reflections which are dulled by thick gray pollen. Calypters yellow with narrow brown tip, their cilia black; halteres yellow. Hypopygium small, black, its outer lamellae a pair of small yellowish organs, fringed with minute yellow hairs, directed backward.

Coxae, femora and tibiae yellow, the tips of posterior femora and the whole of hind tibiae distinctly infuscated; bristles and hairs of fore coxae wholly yellow. Fore femora without noticeable hairs or bristles; middle femora with two strong black bristles at base below and about an equal number of smaller, yellowish bristles near them; posterior femora with a series of black hair-like bristles along dorsal margin; middle femora with a row of bristles of increasing length which end in the preapical bristle; posterior femora with its preapical bristle surrounded by several smaller bristles. Fore and middle tarsi blackened from the tip of first joint, the fore basitarsi (fig. 7) with a row of about five small, slender bristles on lower surface; hind tarsi wholly darkened, concolorous with their tibiae. Joints of fore tarsi as 8–4–3–2–2; of middle tarsi as 9–4–4–3–2; of hind tarsi as 5–5–4–3–2. The structure and chaetotaxy of the legs of this species are similar in most respects to those of *T. utahensis* and figures for the latter species (figs. 8 and 9) will rather well illustrate the legs of *T. diminucosta* n. sp.

Wings (fig. 13) grayish hyaline, without perceptible thickening of the costa; cross-vein oblique and before middle of wing; anal angle evenly rounded, not prominent.

Female.—Like the male in all respects except that legs show no modification in structure or chaetation; the posterior tibiae are wholly yellow, the wings are broader with the anal angle rounded and prominent.

Described from 9 males and 2 females all taken in Logan Canyon, Utah, August 4, 1940, by G. F. Knowlton and F. C. Harmston. Holotype and allotype deposited in the U. S. National Museum, paratypes in the insect collections of the Utah Agricultural Experiment Station, California Academy of Sciences, Ohio State University and University of Kansas.

Taxonomy.—*Teuchophorus diminucosta* n. sp. resembles *T. clavigerellus* Wheeler, the latter species being described from a single male collected in South Dakota. Both have legs of a prevailing light yellow color and are alike in the chaetation of the legs. The two species may readily be separated, however, by the greatly thickened costa in *clavigerellus*, while the costa in *diminucosta* shows no thickening.

MAINTENANCE OF SHADE AND ORNAMENTAL TREES, by P. P. Pirone. Pages xvii and 422 with 174 illustrations. 1941. Oxford University Press, 114 5th Ave., New York. $4.50.

This is the best compilation of information to date on a subject which is of growing interest to the home owner, park superintendent, nurseryman and landscape architect. Although the section of the book which concerns insects and their control appears somewhat limited, it is presumed the user of the book, with a little previous entomological training, could make the proper diagnosis of any insect problem which may arise. However, the satisfactory use of the book by the ordinary home-owner in solving his tree and shrub problems appears doubtful. To those who are directly connected with such problems in their vocation or those who have had entomological experience or training the book will be of invaluable aid.

It is divided into two sections, the first of which deals with general maintenance practices. Subjects covered are, the normal tree; the soil and its relation to trees; transplanting trees; fertilizers and their use; pruning trees and treating wounds; cavity treatments; bracing and cabling; and trees suitable for streets and roadsides.

The second part deals with specific abnormalities of trees and the subjects dealt with by chapters are: Diagnosing tree troubles; Non-parasitic injuries; Insect control; Spraying equipment and practices; Tree diseases and their control; General parasitic diseases; Diseases and insect pests of street and roadside trees; Diseases and insect pests of deciduous ornamental trees and shrubs; Diseases and insect pests of evergreen trees and some shrubs. A selected bibliography and index are appended.

The book is printed on excellent quality paper in large type which makes for easy reading. The chapter titles are in very large type, taking up almost one-third to one-half of a page. To the reviewer these seem to be a waste of space and the added attractiveness is probably not in proportion to costs of publication.

Nevertheless the book is the latest authoritative source of information on the subject and will be a handy reference to all those interested.

—R. H. Davidson.

EFFECT OF BLOCKING HEMOCYTES WITH CHINESE INK AND STAINING NEPHROCYTES WITH TRYPAN BLUE UPON THE RESISTANCE OF THE COCKROACH PERIPLANETA AMERICANA (L.) TO SODIUM ARSENITE AND NICOTINE

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Insects possess natural resistances to the actions of poisonous substances. The resistance to poisoning varies from species to species, from individual to individual, at different times during the life of an insect, and under different conditions (Shepard, 1939, pp. 19–22). The very fact that an insect displays a resistance to poisoning implies that it possesses some means of defense against the action of the poison. It may be considered that the insect, like the vertebrate, possesses a first line of defense in the integumentary, respiratory, and alimentary membranes which separate the external environment from the internal environment in which live the animal's tissues and organs. Behind or inside this integumental barrier operates a cellular defense mechanism, which may act directly by phagocytosis (Ermin, 1939; Huff, 1940; Paillot, 1933) or athrocytosis (Gerard and Cordier, 1934; Lepesme, 1936), or indirectly by antibody or antitoxin formation (Huff, 1940; Paillot, 1933) against foreign or detrimental material.

The purpose of this paper is to describe an attempt to change physiologically the resistance of nymphs of the cockroach *Periplaneta americana* (L.) to sodium arsenite and nicotine poisoning by experimentally influencing the activities of certain cells that might be considered to play a role in its internal defense mechanism.

STATEMENT OF THE PROBLEM

The hemocytes of insects play a defensive role in the organism, at least with respect to phagocytosis and capsule or nodule formation (Ermin, 1939; Huff, 1940; Paillot, 1933; Rooseboom, 1937). Hemocytes can also take up certain substances dissolved in the plasma, as, for example, certain dyes (Ermin, 1939). Similarly, it is known that certain fixed tissue cells in insects have a highly developed capacity for accumulating various dyes from the circulating hemolymph. Because these cells so readily perform this function, they have been called cellular kidneys of accumulation, or nephrocytes (Bruntz, 1904; de Ribaucourt, 1901), the implication being that the nephrocytes thus act in the defense of the organism against these foreign materials. Very conspicuous among these cells are the pericardial nephrocytes (Hollande, 1922; Bruntz, 1909). Whether the hemocytes and nephrocytes can remove various poisons from the hemolymph and thus help to defend the organism against these poisons apparently has not been demonstrated.

Vertebrates possess cells, referred to as the reticulo-endothelial (R-E) system, scattered among their various organs and tissues (Jaffe, 1938), which are known to play an important role in their defense against foreign materials, such as colloidal dyes and discrete particles. Among the outstanding characteristics of the R-E cells is their ability to remove foreign colloid particles (by athrocytosis) and discrete microscopic particles (by phagocytosis) from the circulating blood and tissue fluids. Vertebrate blood cells also participate in defense of the tissues.

Thus it would seem that the defense mechanism of blood cells and R-E cells in the vertebrate might have its counterpart in the hemocytes and nephrocytes in the insect. Lesperon (1937) suggested that the pericardial nephrocytes and the oenocytes of insects are analogous to the vertebrate R-E system. If, in the insect, the hemocytes and the nephrocytes do constitute an internal defense mechanism against foreign materials, the question arises as to whether or not the natural resistance to an insecticide is in part the result of activity by these cells.

One means of attacking this problem is to attempt to interfere with or eliminate the defense activity of the hemocytes and nephrocytes by a blockage technique. Blockage of the nephrocytes with a dye and blockage of the hemocytes with carbon particles could be attempted by injecting these materials into the body cavity of an insect. Both these methods of functional blockage have been used on vertebrate R-E cells with various degrees of effectiveness (Doan, 1939; Jaffe, 1938). In some investigations no effect was discernible, in some the attempted blockage seemed to have a stimulating effect, and in others it had a depressing or partially inhibitory effect upon the R-E cells. Both stimulatory and inhibitory effects appeared to be temporary. Complete blockage of R-E cells is made difficult, if not impossible, because of their marked regenerative capacity.

In the investigation on *Periplaneta americana* reported here, attempts were made to block the hemocytes with Chinese ink and the nephrocytes with trypan blue. It should be emphasized that filling a hemocyte with phagocytized particles or intensely staining a nephrocyte with trypan blue might not necessarily mean the functional elimination of these cells. Morphological blockage may or may not involve functional blockage.

METHODS

Four series of three replicate experiments each were performed. In series I and II blockage of hemocytes with Chinese ink (carbon) particles, and in series III and IV blockage of nephrocytes with trypan blue, was attempted. In series I and III sodium arsenite, and in series II and IV nicotine, was subsequently used in the insecticide tests.

In the two ink series (I and II) each experiment was so designed that the mortalities of the following groups of insects could be compared: (1) Nymphs injected with a suspension of Chinese ink in saline and subsequently poisoned with either sodium arsenite or nicotine, (2) nymphs injected with saline solution only and subsequently poisoned with either sodium arsenite or nicotine, (3) nymphs injected with a suspension of Chinese ink in saline but not subsequently poisoned, and (4) nymphs injected with saline solution only but not subsequently poisoned.

In the two dye series (III and IV) the design of the experiments was the same, similarly involving four groups of injected nymphs, the difference being that groups 1 and 3 were injected with a solution of trypan blue in saline instead of with Chinese ink suspension.

TREATMENT OF INSECTS PREPARATORY TO INSECTICIDE TESTING

In each experiment the procedure was as follows: The body weight and the sex of 40 nymphs were determined individually. The nymphs were then arranged into the 4 groups of 10 each, the groups being as nearly as possible equalized with respect to body weight and sex. Each nymph was then injected with a volume of the required fluid (Chinese ink suspended in saline, trypan blue dissolved in saline, or saline only) equivalent to one one-hundredth of its body weight; for example, an insect weighing 1 gram received 0.01 ml. of fluid. Each insect was enclosed separately in a shell vial, usually 25 x 100 mm., the end of which was covered with a wire screen. After injection the insects were kept for approximately 24 hours in a cabinet at the constant temperature and constant humidity at which the experiments were conducted. At the end of this period, just prior to the insecticide tests, any nymphs that appeared abnormal were replaced by similarly injected nymphs from replacement series.

The roaches used in this investigation consisted of 54 per cent males and 46 per cent females. Series I, II, III, and IV contained 63, 41, 62, and 51 per cent males, respectively. The average body weight of all the roaches was 0.798 gram, and the standard deviation was 0.163 gram.

The extremes of weight were 1.270 and 0.505 gram. The average body weights of the roaches in the respective series were 0.774, 0.830, 0.753, and 0.836 gram.

To prepare a suspension of Chinese ink the end of the hard ink stick was rubbed in saline solution against a small file or, better, the rough inner surface of a glass mortar. When the mortar was used, the ink stick was held and rotated about its long axis with a small stirring motor. When enough ink was considered to have been suspended, the larger particles were centrifuged down and the upper, relatively uniform suspension of fine particles was separated.

In a preliminary experiment the fine suspension was injected into roaches at the rate of 0.01 ml. per gram of body weight to determine to what extent the hemocytes would be loaded with carbon 24 hours after injection. Usually several preliminary experiments with different preparations of ink suspension were required before the concentration was considered adequate. The concentration was considered adequate when nearly all the hemocytes contained ink particles and only an occasional ink particle occurred free in the plasma. The suspension was sterilized by heating over a boiling-water bath for 15 minutes in a loosely covered beaker of water, or by heating at 120° C. in a steam sterilizer. In this way a new suspension was prepared just before each series of experiments was begun. The injections of nymphs in the three experiments of a series were usually carried out on successive days, so that a single suspension was used over a period of less than a week. During this time it was kept at 5–10° C. and was resterilized before and after the injections in each experiment.

Similarly, a series of preliminary experiments were carried out to determine what concentration of trypan blue in saline solution was adequate to stain the nephrocytes an intense blue without appreciably staining other tissues. The intensity of blue color in the pericardial nephrocytes was used as an index. A 0.6-per cent dye solution was considered adequate. It gave an intense stain to the pericardial nephrocytes and only a very slight general stain to other tissues, although some tiny loci of blue stain were distributed among some of the other tissues (for example, the fat body). The dye solution was freshly prepared just before each experiment, because it was found that old solutions did not stain the nephrocytes effectively.

The saline solution injected into the control nymphs and used in preparing the ink suspension and the dye solution was the same as that reported suitable for perfusion of insect tissue (Yeager, 1939). It consisted of 10.93 grams of sodium chloride, 1.57 gram of potassium chloride, 0.85 gram of calcium chloride, and 0.36 gram of magnesium chloride ($MgCl_2.6H_2O$) per liter of solution.

The method of injection (Yeager, 1935; Yeager, Woolley, and Brown, 1932) consisted in inserting the capillary tip of a microinjector pipette into the coxa-femur joint of the insect's left metathoracic leg. The left leg was used because of convenience in handling. The metathoracic leg was used because of its relatively large size. The microinjector consisted of a 0.1-ml. pipette calibrated to 0.001 ml., to one end of which a capillary glass tip was attached. Usually a single tip was used for the injection of the 40 nymphs of a single experiment. First the control nymphs were injected with saline, and then the others were injected with the ink suspension or the dye solution. No special aseptic precautions were taken other than to use sterilized ink suspension and to avoid unnecessary contamination. Usually, but not always, a slight amount of hemorrhage or leakage occurred at the injection site. Nymphs showing excess leakage were replaced by others. Although the meniscus of liquid in the injection pipette could be read to about 0.0002 ml., it is believed that the average accuracy of the injection procedure was not greater than about 0.0005 ml., disregarding the leakage that sometimes occurred after the completion of injection. Although this leakage was not measured, it is believed to have reduced the accuracy to about 0.001 ml. in those cases where it occurred. Most of the nymphs did not show marked leakage subsequent to injection.

INSECTICIDAL TREATMENT OF INJECTED ROACHES

In each experiment the nymphs in groups 1 and 2 were treated with metasodium arsenite ($NaAsO_2$) (series I and III) or nicotine ($C_{10}H_{14}N_2$) (series II and IV), whereas the nymphs in groups 3 and 4 were not poisoned. One gram of metasodium arsenite per 100 ml. of water or either 11.0 or 11.3 per cent by volume of nicotine in water was used. The poison solution was applied to the external surfaces of the membranes between the mesonotum and the metanotum and between the matenotum and the first abdominal tergum. These locations were selected because these membranes are covered by nymphal wing pads, making it practically impossible for the insects to ingest any of the poison.

The insecticide solution was applied with a measured-drop apparatus (McGovran, Phillips, and Mayer, 1940) which delivered known quantities of the solution, as follows:

Weight of Roach (gm.)	Volume of Poison Solution Applied (ml.)
1.250–1.150	0.0060
1.149–1.050	0.0055
1.049–0.950	0.0050
0.949–0.850	0.0045
0.849–0.750	0.0040
0.749–0.650	0.0035
0.649–0.550	0.0030
0.549–0.450	0.0025

An average of 0.005 ml. of solution per gram of body weight was applied. Sodium arsenite was applied at the rate of 0.05 mg. (series I and III) and nicotine at the rate of 0.00055 ml. to the ink-injected roaches (series II) and at 0.00056 ml. to the dye-injected roaches (series IV), all quantities being per gram of body weight. The proper dosage was determined by preliminary experiments in which the concentration of poison was adjusted until it would not cause too low or too high a mortality during the two-week period of observation.

After application of the insecticide each roach was replaced in a vial and held at 24–27° C. and 75–80 per cent relative humidity without food or water.

Each insect was observed daily for 14 days to determine whether it was normal, subnormal, or dead. The subnormal roaches, all of which showed certain symptoms, were classified as (1) almost normal, if they appeared more sluggish than normal insects but otherwise normal, (2) unable to turn over when placed on their backs but able to crawl when placed on their feet, (3) unable to crawl but able to move most of their appendages actively, (4) only able to move their appendages slightly, (5) only able to move some of their appendages very slightly, such as a slight twitching of a tarsus or maxillary palpus, etc. The fifth class was required only for animals treated with nicotine. The condition of the roaches was determined by their reaction when their individual vials were shaken.

RESULTS

The results obtained in these experiments consist of mortality data, observations of the behavior of the insects, and some observations of the extent to which the hemocytes were loaded with ink particles and the pericardial nephrocytes with trypan blue. The observations of behavior and degree of loading are given under Incidental Observations.

MORTALITY DATA

The mortality values obtained on each of the 14 days of observation are represented graphically by curves 1_m, 2_m, 3, and 4 in figs. I to IV, the figure numbers corresponding to the respective experimental series, and the curve numbers to the respective groups. The plotted points are averages of the values from the three experiments within a series.

In fig. I it is shown that, among the sodium arsenite-poisoned insects, the accumulated mortalities of the ink-injected nymphs (curve 1_m) were consistently much greater than those of the saline-injected nymphs (curve 2_m), and that no mortality occurred among the unpoisoned ink- and saline-injected nymphs used as controls (curves 3 and 4). On the fourteenth day the accumulated mortality was 87 for group 1 and 40 per cent for group 2. The curves indicate that the resistance to sodium arsenite poisoning was reduced by the injection of Chinese ink, insofar as a lowering of resistance is reflected by these tests. In each of the three experiments of this series on the fourteenth day of observation the mortalities were 80, 90, and 90 per cent for group 1, and 50, 20, and 50 per cent for group 2. The means of group 1 (87) and group 2 (40) have a highly significant difference (47), as indicated by a standard error of difference of 2.7.

When nicotine was used (fig. II), after the first two or three days the average accumulated mortality was consistently greater in the ink-injected poisoned nymphs (curve 1_m) than in the saline-injected poisoned nymphs (curve 2_m), and on the fourteenth day the mortalities were 70 (group 1), 57 (group 2), 3 (group 3), and 13 (group 4) per cent. Curves 3 and 4 indicate that the mortality of the unpoisoned control nymphs (groups 3 and 4) is insignificant relative to the mortality of the poisoned nymphs. Although after about the second day curve 1_m is consistently higher than curve 2_m, the difference is not so great as in fig. I. Therefore, whether or not the mortalities of the two groups differ significantly is more questionable. In the three experiments of this series, on the fourteenth day the mortalities were 60, 50, and 100 per cent for group 1; 50, 40, and 80 per cent for group 2; 0, 10, and 0 per cent for group 3; and

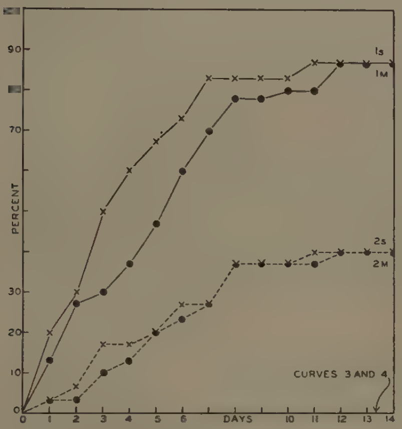

FIG. I. SERIES I. CHINESE INK – SODIUM ARSENITE
CURVE 1s (GROUPS 1): SUBNORMALITIES, INK-ARSENITE, X—X
CURVE 1M (GROUPS 1): MORTALITIES, INK-ARSENITE, ●—●
CURVE 2s (GROUPS 2): SUBNORMALITIES, SALINE-ARSENITE, X---X
CURVE 2M (GROUPS 2): MORTALITIES, SALINE-ARSENITE, ●---●
CURVES 3 AND 4 (GROUPS 3 AND 4) HAVE ZERO MORTALITIES AND ARE NOT SHOWN

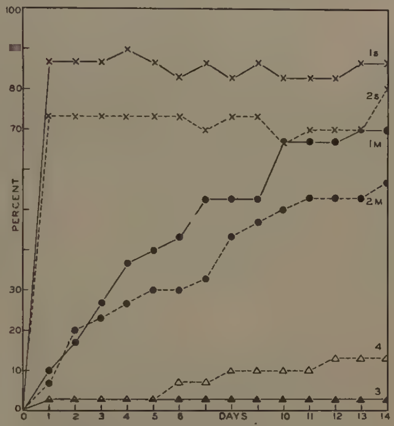

FIG. II. SERIES II. CHINESE INK – NICOTINE
CURVE 1s (GROUPS 1): SUBNORMALITIES, INK-NICOTINE, X—X
CURVE 1M (GROUPS 1): MORTALITIES, INK-NICOTINE, ●—●
CURVE 2s (GROUPS 2): SUBNORMALITIES, SALINE-NICOTINE, X---X
CURVE 2M (GROUPS 2): MORTALITIES, SALINE-NICOTINE, ●---●
CURVE 3 (GROUPS 3): MORTALITIES, INK ONLY, ▲—▲
CURVE 4 (GROUPS 4): MORTALITIES, SALINE ONLY, △---△

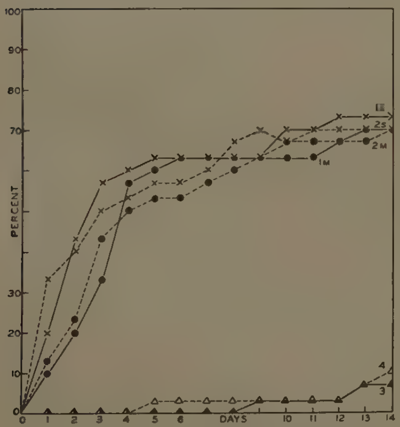

FIG. III. SERIES III. TRYPAN BLUE – SODIUM ARSENITE
CURVE 1s (GROUPS 1): SUBNORMALITIES, DYE-ARSENITE X—X
CURVE 1M (GROUPS 1): MORTALITIES, DYE-ARSENITE ●—●
CURVE 2s (GROUPS 2): SUBNORMALITIES, SALINE-ARSENITE X---X
CURVE 2M (GROUPS 2): MORTALITIES, SALINE-ARSENITE ●---●
CURVE 3 (GROUPS 3): MORTALITIES, DYE ONLY ▲—▲
CURVE 4 (GROUPS 4): MORTALITIES, SALINE ONLY △---△

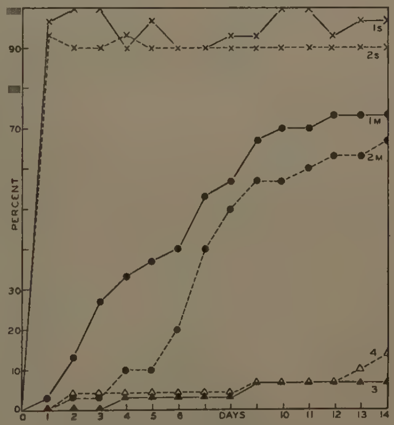

FIG. IV. SERIES IV. TRYPAN BLUE – NICOTINE
CURVE 1s (GROUPS 1): SUBNORMALITIES, DYE-NICOTINE X—X
CURVE 1M (GROUPS 1): MORTALITIES, DYE-NICOTINE ●—●
CURVE 2s (GROUPS 2): SUBNORMALITIES, SALINE-NICOTINE X---X
CURVE 2M (GROUPS 2): MORTALITIES, SALINE-NICOTINE ●---●
CURVE 3 (GROUPS 3): MORTALITIES, DYE ONLY ▲—▲
CURVE 4 (GROUPS 4): MORTALITIES, SALINE ONLY △---△

20, 0, and 20 per cent for group 4. The means of group 1 (70) and group 2 (57) have a difference of 13 and a standard error of difference of 4.0, this difference being on the border line of significance. However, because the average curve of group 1, except during the first 3 days, trends consistently above the average curve of group 2, and because the same is true of the individual curves for groups 1 and 2 in each of the three experiments in this series, it is considered that, insofar as these tests indicated, the injection of Chinese ink into the roaches slightly lowered their resistance to poisoning by nicotine.

Similar average curves are shown in fig. III to illustrate the results of the experiments in which the nephrocytes were intensely stained with trypan blue and sodium arsenite was applied. The figure shows that groups 1 and 2 (curves 1_m and 2_m) had similar average accumulated mortalities, which were identical on the fourteenth day (70 per cent), and that the control groups 3 and 4 (curves 3 and 4) had insignificant mortalities of 7 and 10 per cent, respectively. In the three experiments of this series the mortalities on the fourteenth day were 90, 40, and 80 per cent for group 1; 90, 50, and 70 per cent for group 2; 0, 10, and 0 per cent for group 3; and 0, 20, and 10 per cent for group 4. It is obvious that groups 1 and 2 did not differ significantly, and that the mortalities of groups 3 and 4 were insignificant. The curves indicate that the resistances of the roaches to sodium arsenite poisoning were not lowered by the injection of trypan blue.

In the experiments in which the roaches were injected with trypan blue and treated with nicotine (fig. IV), the average accumulated mortality for group 1 (dye-nicotine) was consistently greater than that for group 2 (saline-nicotine), but, except from about the second to the sixth day, the difference between the groups was not great. The mortalities in groups 3 and 4 were not significant. On the fourteenth day the mortalities in the three experiments of this series were 90, 50, and 80 per cent for group 1; 80, 60, and 60 per cent for group 2; 20, 0, and 0 per cent for group 3; and 10, 10, and 22 per cent for group 4. The means of group 1 (73) and group 2 (67) have a difference of 6 and a standard error of difference of 3.3, this difference not being significant. Although the consistent trend of curve 1_m above curve 2_m might also appear to indicate a lowering of the resistance of the roaches by the injection of trypan blue, it is considered that this is not demonstrated. A consistent trend, without crossing, occurred in only one of the experiments of this series. The results are therefore considered to indicate that injection of trypan blue did not decrease the resistance of the roaches to poisoning by nicotine.

INCIDENTAL OBSERVATIONS

In all the experiments of series I and II, when the ink-injected nymphs were handled 24 hours after injection, prior to poisoning, they usually appeared slightly but definitely less vigorous than the corresponding saline-injected roaches. The dye-injected roaches, on the other hand, were just as vigorous as the corresponding saline-injected nymphs.

The application of the sodium arsenite solution to the nymphs of groups 1 and 2 in series I and III did not have an immediate effect on their activity, whereas usually the application of the nicotine solutions to the corresponding nymphs in series II and IV produced immediate and violent body activity, although some were only slightly stimulated. In many instances violent body activity was followed by paralysis within a minute. Twenty-four hours after application of the nicotine some of the nymphs were so bloated that their intersegmental membranes, including those of the neck, were greatly extended. At the same time the surviving insects showed various degrees of recovery from the initial paralysis. Some appeared normal, but the others showed symptoms varying from a slight sluggishness to a marked paralysis in which only slight twitching movements of the appendages occurred when the vials containing the roaches were shaken.

Of the 60 roaches poisoned in each series, the percentages killed, the series numbers, and the insecticide applied were 63.3 (I) sodium arsenite, 63.3 (II) nicotine, 68.3 (III) sodium arsenite, and 70.0 (IV) nicotine. Of these, the percentages of those whose symptoms of toxicity lasted for 24 hours or less were 21.7 (I), 5.0 (II), 21.7 (III), and 1.7 (IV); for 48 hours or less, 46.6 (I), 16.7 (II), 53.3 (III), and 8.3 (IV); and for more than 48 hours, 11.7 (I), 46.6 (II), 15.0 (III), and 61.7 (IV). The percentages of roaches that were subnormal but not dead at the end of the 14-day experimental period were 0 (I), 20.0 (II), 1.7 (III), and 23.3 (IV).

These values show that the applied sodium arsenite and nicotine solutions finally produced about the same average mortality in the four series of experiments. They also show that on an average 21.7 per cent of the arsenite-killed nymphs showed symptoms of toxicity that lasted only 1 day, whereas only 3.4 per cent of the nicotine-killed nymphs had symptoms lasting only 1 day. Similarly, 50.0 per cent of the arsenite-killed nymphs had symptoms lasting 2 days, as compared with 12.5 per cent for the nicotine-killed insects. In contrast with this, 54.2 per cent of the nicotine-killed insects and only 15.9 per cent of the arsenite-killed nymphs showed symptoms which persisted for more than 2 days.

A more detailed analysis of these results has shown that nearly all the arsenite-affected nymphs exhibited symptoms in a continuously progressive manner; that, is whether the insects passed from normal to dead in 1 day or 6 days, most of them (86.4 per cent of those killed) did not remain more than 1 day in an unaltered subnormal condition, as indicated by the observed symptoms. Once symptoms of toxicity appeared in an arsenite-poisoned roach, they progressed toward death with no signs of recovery, either partial or complete.

On the other hand, only 17.9 per cent of the nicotine-killed roaches showed similarly progressive symptoms. The others (82.1 per cent) exhibited symptoms in a much more variable manner; some remained in various subnormal conditions, without alteration, for 2 to 11 days. Individuals sometimes remained several days in one condition, and then changed to another condition and remained in that for several days, and so on. About one-third (30.8 per cent) of the nicotine-killed roaches showed some sign of recovery. Some of the less affected roaches appeared to recover their normal condition, whereas the others showed partial but never complete recovery. Most of those insects that appeared to be near death and later showed partial recovery eventually died or were near death at the end of the 14-day experimental period. The nicotine-killed insects thus exhibited variable symptoms of toxicity, most of the time progressing toward death but sometimes regressing toward the normal (partial recoveries).

The differences in the duration of symptoms between the arsenite- and nicotine-poisoned nymphs are also shown by the subnormality curves in figs. I to IV. Curves 1_s and 2_s represent the accumulated percentages of subnormal roaches in groups 1 and 2, respectively, during the 14-day experimental period. The areas between curves 1_s and 1_m and between curves 2_s and 2_m represent the percentages of subnormal but not dead roaches. In figs. II, III, and IV these areas overlap. In figs. I and III the subnormality and mortality curves are not very widely separated, whereas, in figs. II and IV they are widely separated, particularly in the earlier portion of the experimental period, an indication that a greater percentage of the nicotine-poisoned nymphs than of the arsenite-poisoned nymphs quickly become subnormal and persisted in this condition for a relatively longer time.

Microscopic observations of hemolymph from ink-injected roaches taken from a replacement series were used as an index to the degree to which the hemocytes of the insects used in the experiments were loaded with Chinese ink particles. Figs. V and VI show part of a drop of hemolymph from a replacement roach that had been heated in water to 60° C. for 5 minutes to inhibit coagulation, and illustrate the degree to which the hemocytes were usually loaded with ink particles, although there was some variation between individual roaches and the degree of cellular agglutination may be somewhat more marked than usual. In all the examined hemolymphs some of the hemocytes appeared completely loaded with ink particles (figs. V, *f*, *g*, and *h*; and VI, *h*, *i*, and *j*), some contained none (figs. V, *a* and *b*, and VI, *b*), and most contained intermediate quantities of phagocytized ink (figs. V, *c*, *d*, and *e*, and VI, *e*, *f*, and *g*). Considerable cellular agglutination usually occurred (figs. V, *i* to *o*, and VI). A number of the ink-injected roaches whose hemolymphs were examined for degree of phagocytosis of ink particles were also dissected and their tissues examined microscopically. In all roaches with ink-laden hemocytes numerous tiny deposits of ink were found widely distributed among the tissues, especially the fat body. These small ink deposits were probably agglutinated hemocytes containing phagocytized and encapsulated ink particles.

Similarly, replacement roaches were used as indices of the degree of staining of the nephrocytes in the experimental insects. Although some individual variation occurred, the pericardial nephrocytes were always stained deep blue and usually were very deeply stained, as shown in fig. VII.

At the end of the observation period many hemocytes still contained ink particles and the pericardial nephrocytes remained deeply stained. Considerable blue dye was still in the pericardial nephrocytes of several roaches that were examined about five and a half months after injection of the trypan blue.

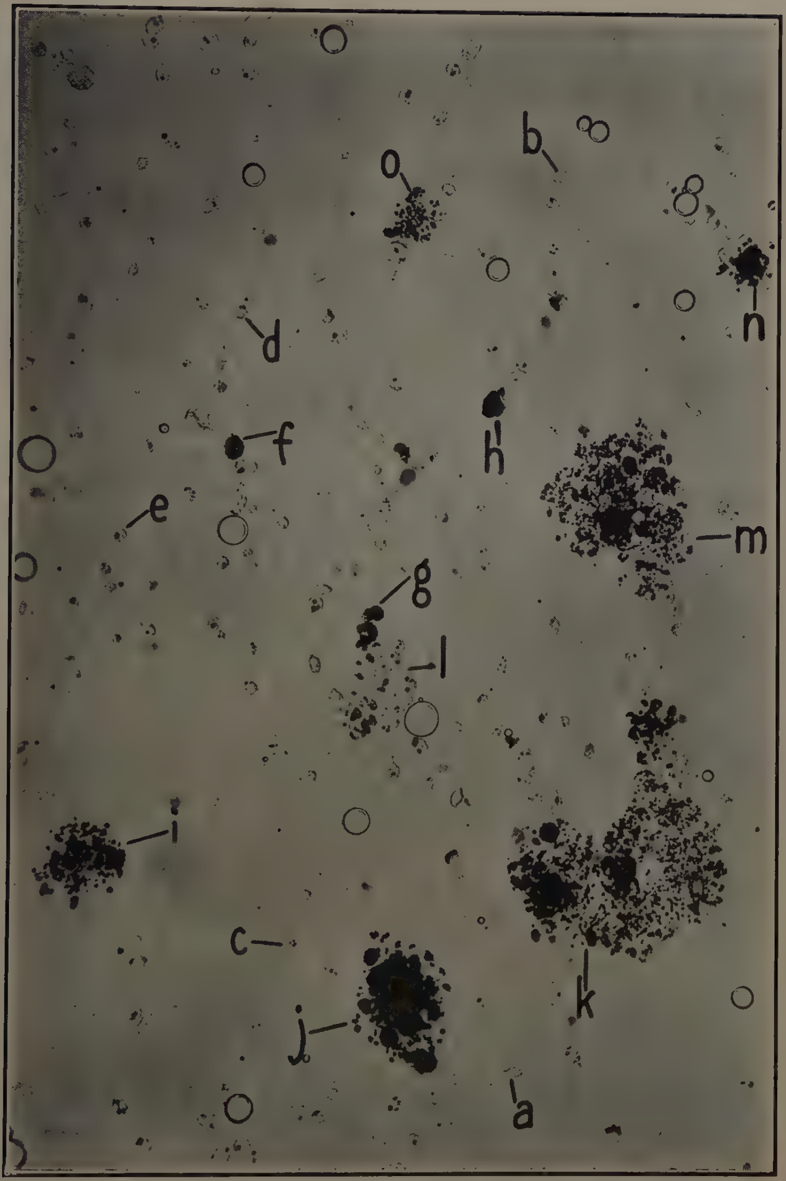

Fig. V.—Hemolymph from a roach 24 hours after injection of Chinese ink suspension, showing the extent of phagocytosis that occurred in the roaches of groups 1 and 3 in series I and II. A few cells (*a* and *b*) contain no ink, some (*c*, *d*, and *e*) a little ink, and some (*f*, *g*, and *h*) are heavily loaded. Cellular agglutina occur at *i*, *j*, *k*, *l*, *m*, *n*, and *o*. The plasma is almost free of ink particles. Part of a drop of unstained hemolymph from nymph heated in water at 60° C. for 5 minutes to prevent coagulation. 45 × objective; 10 × ocular.

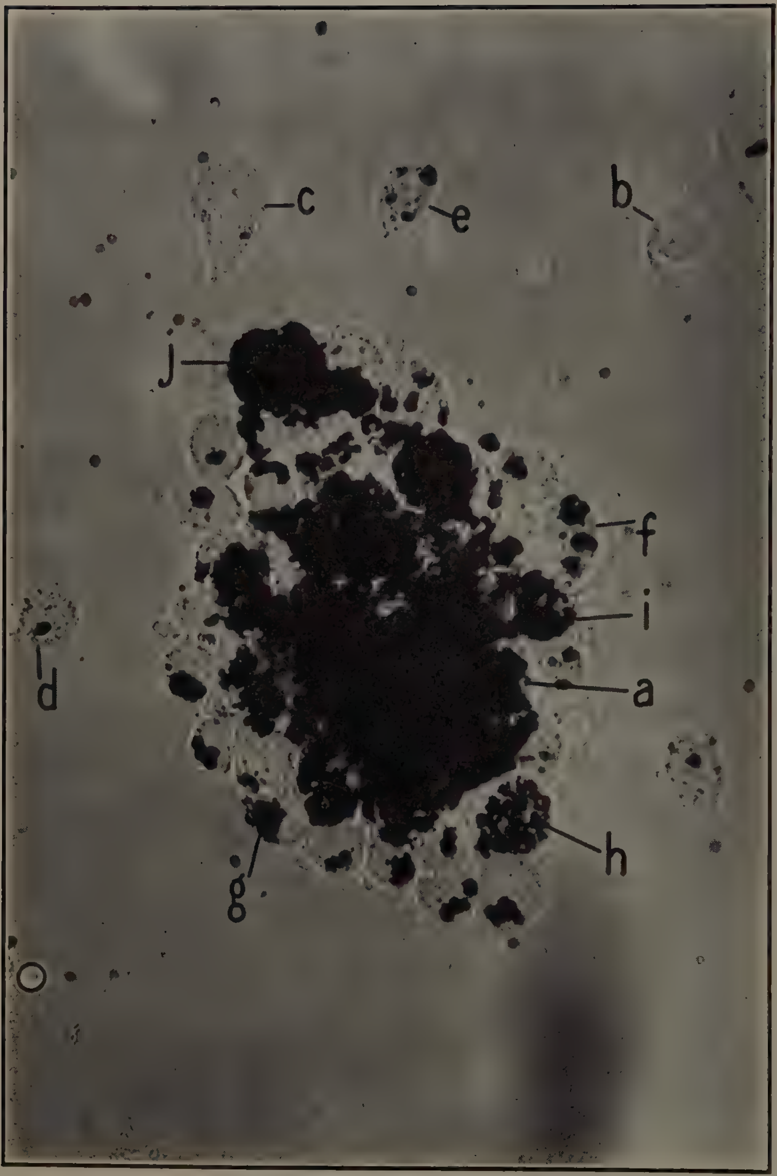

Fig. VI—Cell agglutinum *j*, fig. 5, highly magnified. Some of the ink (*a*) massed in the center of the agglutinated hemocytes may be encapsulated, but most of it is phagocytized. Cell *b* contains no ink. Slight phagocytosis is illustrated by the cells at *c* and *d;* moderate phagocytosis by the cells at *e*, *f*, and *g;* and marked phagocytosis by those at *h*, *i*, and *j*. 93 × objective (oil); 10 × ocular.

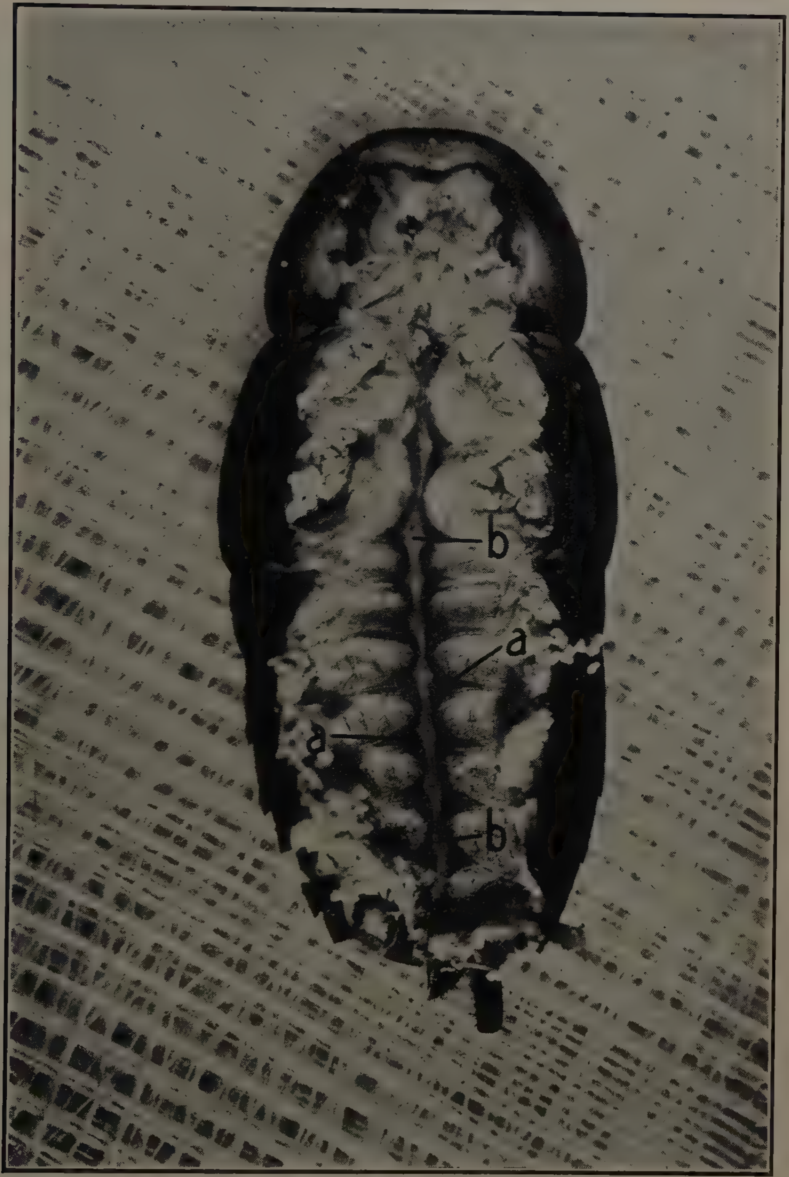

Fig. VII—Dissected roach 24 hours after injection of trypan blue solution, showing the deeply stained pericardial nephrocytes (*a*) distributed among the alary muscle fibers along the heart (*b*). This photograph illustrates the degree of staining of the nephrocytes in the experimental roaches of groups 1 and 3 in series III and IV. × 4 approx.

Roaches injected with the Chinese ink suspension in amounts greatly exceeding those required to load the hemocytes to the degree indicated in fig. 5 appeared very sluggish when observed 24 hours after the injections and later showed considerable mortality, even among those not poisoned with arsenite or nicotine, in which case the experiment was discarded. Similar high mortalities were never observed among the unpoisoned dye-injected roaches.

DISCUSSION

The results of the experiments reported here show that only negligible mortalities and subnormalities occurred among the unpoisoned control roaches, whether they had been injected with Chinese ink suspension, trypan blue solution, or only saline. Among the poisoned roaches, the mortalities of the ink-injected nymphs were greater than those of the corresponding saline-injected nymphs, particularly when sodium arsenite was used, whereas no difference in mortality between the dye-injected and the corresponding saline-injected nymphs occurred when either the arsenite or nicotine was used. These mortalities suggest that, insofar as the insecticide tests indicate, functional blockage of the hemocytes but not of the nephrocytes was achieved in spite of the fact that the pericardial nephrocytes were deeply stained and apparently heavily loaded with the trypan blue.

Although indicating that some degree of functional blockage of the hemocytes was produced in the ink-injected nymphs poisoned with nicotine and, particularly, with sodium arsenite, these results do not show what functions were blocked. The injection of Chinese ink particles tended, not only to load individual hemocytes with particles, but also to produce more or less agglutination of hemocytes (figs V and VI). Some of the cell agglutina were probably removed from the circulating hemolymph by being caught in the tissue spaces (Ermin, 1939), which would account for at least some of the minute deposits of ink among the tissues. The injection of the ink, therefore, probably not only caused loading and some agglutination of the hemocytes, but also produced a decrease in the number of circulating hemocytes. Thus a functional loss of hemocytes from the circulation might result from sufficient phagocytosis of ink, agglutination of phagocytes, actual removal of cells from circulation, or all three processes.

In these experiments the functional blockage of hemocytes was expressed by a relative increase in the mortality of the ink-injected roaches, indicating lowering of their resistance to nicotine and, particularly, sodium arsenite. Three working hypotheses can be suggested to explain the manner in which the resistance of the roaches was lowered by loading the hemocytes with particles: (1) Direct counteraction of those cells against the absorbed poison might have been interfered with. Although it has been shown that administration of arsenicals can produce changes in the hemocytes of poisoned southern armyworm larvae (Yeager and Munson, unpublished), locusts (Pilat, 1935), crickets (Lepesme, 1936), and *Calliptamus* (Tareeva and Nenjukov, 1931), it is not known whether the hemocytes of poisoned insects defend the organisms by taking up the poisons from the hemolymph plasma. It is not impossible, however, that they might remove certain poisons from the hemolymph by absorption or phagocytosis and thereby tend to protect the other tissues of the organism from its toxic action. (2) It is possible that interference with some indirect counteraction of the cells against the absorbed poison occurred. Although virtually nothing is known regarding this possibility, it is conceivable that hemocytes of a poisoned insect might be stimulated to produce antitoxic substances and to liberate them into the plasma as a part of the organism's defensive reaction to the poison. (3) The loaded hemocytes may have been less able to phagocytize bacteria that may have been in the hemolymph of the injected insects. Under such circumstances increased bacterial action in the organisms might be a factor tending to increase the mortality in the insecticide tests. Again virtually nothing is known regarding the relationship between the effect of completed phagocytosis and the ability of insect phagocytes to ingest other particles.

Whatever may be the process whereby injection of Chinese ink particles influences the internal defense mechanism, it would seem that the functional loss of hemocytes from the circulating hemolymph tends to lower the resistance of the injected insect to sodium arsenite and, to a slight extent, to nicotine.

The results of these experiments have not supplied an answer to the question as to whether or not the hemocytes and nephrocytes of the cockroach correspond functionally to the reticulo-endothelial system of the vertebrate. They do suggest, however, that the hemocytes play some kind of a role in the internal mechanism whereby the insect maintains a resistance to the applied poisons. The failure to block functionally the nephrocytes with trypan blue does not prove that these cells do not play a defensive role in the organism with respect to poisons. It is quite possible that functional blockage of these cells by the injected dye is a temporary process and that evidence of blockage can be obtained under certain other experimental conditions. If an internal defense mechanism is an effective one, attempts to block it functionally might be expected to meet with many difficulties. In the present experiments considerable difficulty was encountered in the attempts to produce adequate blockage of the hemocytes with injected ink particles and also to find a combination of poison dosage and natural resistance of insect that would give adequate mortalities of the poisoned, saline-injected roaches in the 14-day experimental period. Further investigation is therefore necessary to establish definitely whether or not the nephrocytes act in the defense of the insect against a poison.

The oenocytes are considered by some authors to function as nephrocytes because, like the pericardial and other nephrocytes, they can take up certain dyes injected into the hemolymph. The suggestion of Lesperon (1937) that the insect nephrocytes and oenocytes are functionally analogous to the vertebrate reticulo-endothelial cells is based upon their athrocytic ability.

To reduce the possibility of adsorption of absorbed poison by carbon particles carried free in the circulating hemolymph, the roaches were not poisoned until 24 hours after injection, at which time practically all the injected ink had been removed from the plasma by the hemocytes.

If the ink did adsorb poison, the latter must have first been taken up by the phagocytes containing the ink. Adsorption of poison by free ink particles is considered to have occurred to a negligible extent, if at all.

Chinese ink was preferred to fluid India ink, because the unknown composition of the liquid portion of the India ink seemed to offer a greater number of unknown factors and hindered the use of a suitable control saline for injection into the group 2 roaches. Furthermore, the particle size of the Chinese ink was smaller.

It should be emphasized that as close a comparison cannot be made between one series of experiments and another as can be made between the experiments within a series or between the groups within a single experiment. Nevertheless, the comparison of the subnormality curves in figs. I and III with those in figs. II and IV, and of the symptomatic behavior of the arsenite-poisoned and the nicotine-poisoned nymphs, indicate marked differences in the toxicological actions of sodium arsenite and nicotine. Whereas the arsenite appeared to have a continuously progressive toxic effect, any such effect of nicotine application was complicated by immediately produced stimulatory and subsequent inhibitory changes suggestive of rapid absorption and direct action of the absorbed nicotine on the insect's nervous system. This and the occurrence of some partial recovery among the nicotine-poisoned roaches indicate that, insofar as shown by the observed symptoms, the effect of the nicotine was more complex than that of the sodium arsenite.

SUMMARY AND CONCLUSIONS

The role played by the hemocytes and the nephrocytes of the cockroach *Periplaneta americana* (L.) in the maintenance of the insect's resistance to poisoning by sodium arsenite and nicotine was investigated. The methods used involved loading the hemocytes with injected Chinese ink (carbon) particles, or loading the nephrocytes with injected trypan blue, and determining by contact applications of insecticide whether or not the attempted blockage had altered the resistance of the injected nymphs to the poisons.

The results indicated that functional blockage of the hemocytes but not of the nephrocytes was obtained, that blockage of the hemocytes with Chinese ink caused a decrease in the resistance of the roaches to sodium arsenite and, to a slight extent, to nicotine, and that loading the nephrocytes with trypan blue had no effect on the resistance of the roaches to either poison, insofar as was indicated by the insecticide tests. Daily observations of the symptoms of toxicity indicated that the action of the nicotine was more complex than that of sodium arsenite.

Several possibilities are discussed regarding the operation of an internal defense mechanism in the insect and the possible functional analogy that may exist between the hemocytes and nephrocytes of the insect and the reticulo-endothelial system of the vertebrate.

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THE ANATOMY AND HISTOLOGY OF THE PROVENTRICULUS OF IPS RADIATAE HOPKINS

(Coleoptera: Scolytidae)

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Ips radiatae Hopkins is one of the minor species of a large group of bark beetles commonly found in coniferous trees. It breeds under the bark of various species of pine, notably in weakened and recently felled Monterey pine (*Pinus radiata* D. Don.)—a non-commercial tree species native to the coastal region of California. Although not economically important, *Ips radiatae* is probably anatomically similar to the better known and more destructive members of the genus. This report of investigations on the anatomy and histology of the proventriculus of the adult bark beetle is therefore presented with the expectation that it will be of interest in connection with similar studies on other species.

The proventriculus of *Ips radiatae* is a specialized portion of the alimentary canal which lies within the prothorax, immediately in front of the ventriculus and just behind the sac-like crop (fig. 1). Its corrugated exterior surface is comprised of powerful bands of muscle encircling a complicated inner structure armed with strong cuticular plates and teeth. It probably functions as a grinding-straining organ to reduce the size of food particles before the latter are passed on to the stomach.

Since the proventriculus is thought by some investigators to be of taxonomic value, the lack of information on this structure is rather surprising. Various writers, notably Beal (1927), Hopkins (1915), Schedl (1931), and Swaine (1918) in this country, and Fuchs (1911), Neusslin (1911–12), Sedlaczek (1902) and others in Europe have published the results of investigations on the morphology of the proventriculus in various scolytids. However, much remains to be done. The researches of these men have been sufficiently detailed to show that the possibilities of separating the various groups of bark beetles by proventricular characters are extensive; but as pointed out by

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[1] Formerly a graduate student at the University of California at Berkeley, where this work was conducted.

Swaine, the lack of a comprehensive study of a large number of genera, species, and individuals prevents the use of these characters in taxonomy.

PREPARATION OF MATERIAL FOR SECTIONING

Adult bark beetles were collected from felled Monterey pine trees late in the fall of 1935, and kept in rearing cages in the laboratory several weeks prior to killing. Most of the beetles had access to food material in the form of fresh sections of wood brought in at the time of collection. An attempt was made to obtain beetles with an empty alimentary tract by separating them from their food supply several days before killing them. This method was unsuccessful in most cases. The great majority of specimens were killed and sectioned before they had entirely voided the ingested food material.

Preparatory to dissection the beetles were killed in hot (70° C.) Bouin's solution in which they were left to fix for six hours while the liquid cooled to room temperature. Upon being removed from the fixative they were washed in several changes of 50 per cent ethyl alcohol and stored in 70 per cent ethyl alcohol until needed. With the tissue in this state of dehydration the fore intestine could be readily removed from the body.[2] Each specimen was then run up, at one hour intervals, through 85 per cent, 95 per cent, and 100 per cent concentrations of ethyl alcohol into a solution of 100 per cent ethyl alcohol and ether mixed in 1 : 1 proportions. After remaining in this medium for 10 minutes the specimens were infiltrated in a corked bottle of 2 per cent celloidin for 36 to 48 hours. Shorter periods of infiltration were tried, but due to poor penetration of the celloidin into the tissues the latter crumbled and folded in sectioning for lack of a sufficient supporting matrix. Each specimen was transferred from celloidin to chloroform by the drop method and subsequently re-infiltrated and re-imbedded in paraffin (56° C. m.p.). It was found that when the specimens were left several days in chloroform better paraffin infiltration resulted, and fewer sections were lost by the celloidin dropping out of the paraffin. The orientation of the tissue within the block was indicated by marking a line on the paraffin above the specimen, after which the block was trimmed, mounted and sectioned with a rotary microtome adjusted to cut sections 8 to 10 microns thick. Sections cut less than 7 microns thick crumpled excessively. The sections were mounted on microscope slides coated with a thin layer of Mayer's albumen, and dried for several days at room temperature.

The tissues were stained with alkaline Delafield's haematoxylin, and the depth of the stain adjusted by shifting the slides back and forth from acid to alkaline 70 per cent ethyl alcohol. Eosin Y in 95 per cent ethyl alcohol was used as a counterstain. The sections were then cleared in xylol and mounted in balsam.

To facilitate the interpretation of the serial sections, several whole mounts of the fore intestine were made. In addition the sclerotized grinding-sieve structure of the proventriculus was boiled in alkali and cleared in xylol, then mounted in a transverse position. In the third type of whole mount made, the fore intestine was split longitudinally with a very sharp razor and the two halves folded back on the slide. It was found that staining the whole mounts obscured the internal plates of the proventriculus, since the surrounding cellular tissue absorbed the stain.

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[2] The technique described here is a modification of McIndoo's method of double imbedding (Kennedy, 1932).

GENERAL ANATOMY OF THE PROVENTRICULUS

The fore intestine (fig. 1) of the adult bark beetle is a tubular structure composed of four distinct parts. Behind the mouth opening (*Mth*) lies the narrow, fluted pharynx (*Phy*) which gradually enlarges posteriorly into the tubular oesophagous (*Oe*). The latter in turn leads into the crop (*Cr*), a convoluted, bag-like structure that is smooth and globular when distended with food, without folds or ridges on its surface. The posterior walls of the crop attach to the front margin of the proventriculus (*Pvent*), which is bell-shaped and narrowed caudad. It is connected to the ventriculus (*Vent*) through the cardia (*Car*).

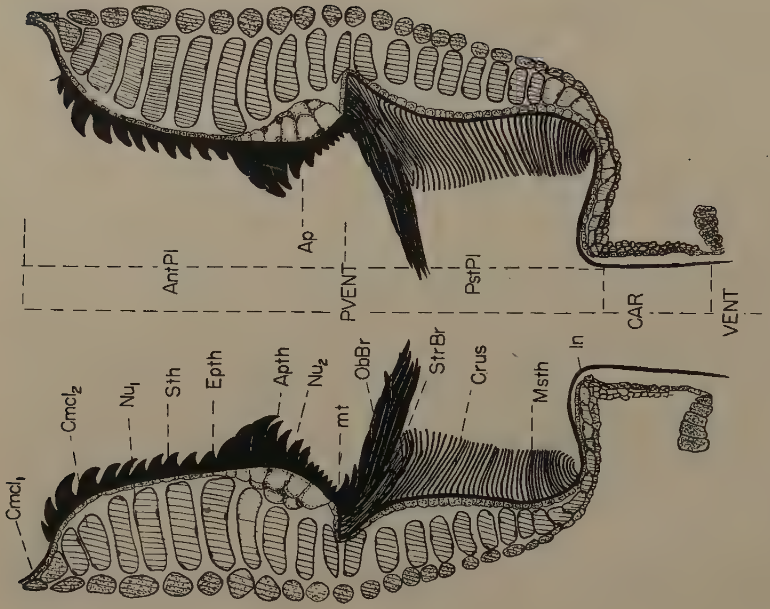
When the proventriculus is viewed transversely, with the crop dissected away so that it is possible to look directly down the alimentary tube, it appears octagonal in shape (fig. 2). The complexity of the internal structure becomes apparent from this aspect. The exterior surface of the organ is comprised of eight segments of circular muscle bands (*Musc*). Within the muscle bands lie the sclerotized plates, the anterior halves (*AnPl*) appearing to be just beneath the muscles, and the posterior halves (*PoPl*) toward the center. Eight sets of bristles (*Br*), corresponding to the eight plates, arise at the junctures of the anterior and posterior halves and project into the lumen. Through the small opening in the center, the caudal portions of the posterior plates may be seen.

From the lateral aspect (fig. 3) the longitudinal ridges (*Rdg*) of the proventriculus are visible. These ridges are eight in number and arise at relatively wide intervals in the caudal margin of the crop and converge posteriorly toward the cardia. They represent the outward-projecting longitudinal axes of the proventricular plates to which attach the circular muscle bands.

DETAILED STRUCTURE OF THE PROVENTRICULAR PLATES

The internal appearance of the proventricular wall is shown diagrammatically in longitudinal section in Figures 4 and 8. The nomenclature followed in naming the various parts is a modification of that used by Hopkins (1915). The sector shown in detail (fig. 8) is made up of the left and right halves of two adjacent plates, and the complement of each is indicated by dotted lines. Thus the outline in its entirety represents two whole plates.

The sclerotized parts indicated within the bracket "A" are considered to form a single plate, since Beal (*op. cit.*) has shown that these parts arise from a single ridge in the development of a bark beetle. Each plate is secondarily divided into four subequal areas. The transverse suture (*mt–m′t′*) separates the anterior and posterior regions, and the


Cmcl$_1$
Cmcl$_2$
Nu$_1$
Sth
Epth
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mt
ObBr
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Crus
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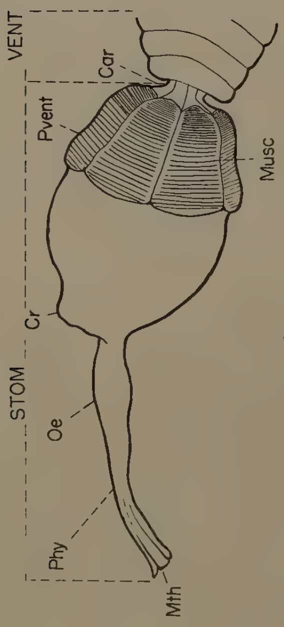
In
AntPl
Ap
PVENT
PstPl
CAR
VENT

4


VENT
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Pvent
Musc
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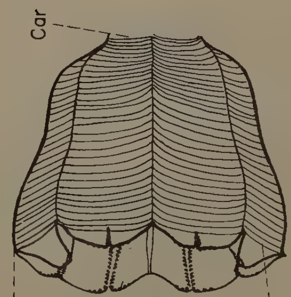
Oe
Phy
Mth

1


Car

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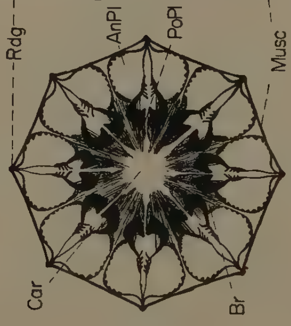

Rdg
AnPl
PoPl
Musc
Car
Br

2

ridge bisects the plate longitudinally. The anterior plate is nearly oblong in shape, but its margins are slightly divergent in front. The left and right halves are similar in appearance, each being smooth except along the toothed margin. The anterior teeth (*Sth*) are small and inconspicuous, but gradually approach in size the molar structures of the anterio-lateral region. The teeth in the mid-lateral margin are reduced, while those (*Apth*) on the posterior lateral margin or apex (*Ap*) are large. Distally, each successive apical tooth is wider than the one preceding it. The teeth immediately in front of and adjacent to the transverse suture have additional backward projections, and approach in shape the masticatory teeth (*Msth*) of the posterior plate. Lateral to the apex of the anterior plate, a group of long bristles, the marginal fringe (*Mf*), project into the lumen.

At the transverse suture there arises from the lateral margin of the plate a group of fine straining bristles (*StrBr*) which project inward. Behind these bristles occur long saber-like bristles (*ObBr*) which also project toward the center, above the points of the masticatory teeth. These two groups of bristles effectively block the central passage between the anterior and posterior plates, so that when the proventriculus is contracted the food must pass between the lamellate grinding teeth of the posterior plates before reaching the stomach.

The posterior plate supports two rows of doubly toothed lamellae that converge caudad at the cardia. In cross sections of the proventricular wall (figs. 6 and 7) the lamellae appear to be hatchet shaped. Each is made up of a narrow basal *crus* (corresponding to Hopkins' femur of the masticatory tooth) that supports a wide, blunt masticatory. On the instep of the crus there arises a single crural tooth (*Crth*). The latter is relatively long on the anterior lamellae, and the margins of the masticatory teeth are entire; but on the posterior lamellae they are much shorter and the margins of the masticatory teeth are beset with bristles.

EXPLANATION OF PLATE I

Fig. 1. Lateral view of the anterior part of the alimentary tract showing the position of the proventriculus in relation to other organs of the fore intestine. ×25.

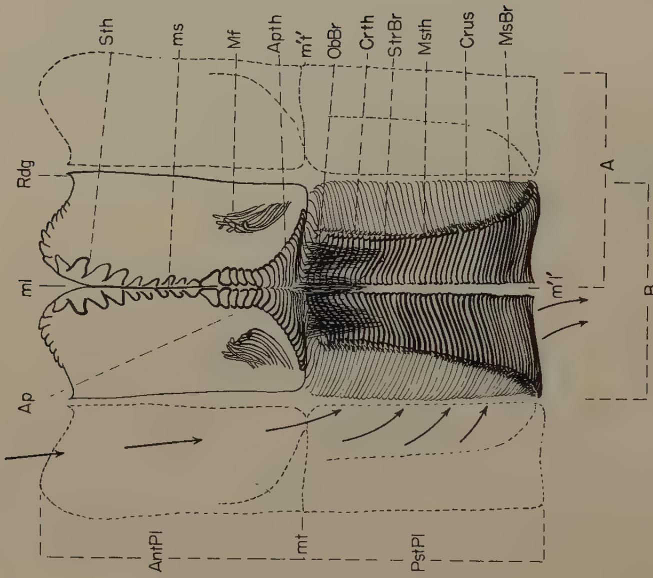
Fig. 2. The proventriculus as it appears in cross section, looking directly down the alimentary tube. ×38.

Fig. 3. Lateral view of the proventriculus with the crop and ventriculus removed. ×38.

Fig. 4. Longitudinal section through the proventriculus showing the elements of the proventricular wall and the arrangement of the internal sclerotized structures. ×76.

LIST OF ABBREVIATIONS

AntPl, anterior plate; *Ap*, apex; *Apth*, apical teeth; *Car*, cardia; $Cmcl_1$, outer band of muscles; $Cmcl_2$, inner band of muscles; *Cr*, crop; *Crth*, crural teeth; *Crus*, shank of the lamella; *Epth*, epithelium; *In*, intima; *Ins*, insertion of plates; *Mf*, marginal fringe; *ml-m‘l’*, median longitudinal suture; *MsBr*, masticatory brush; *Msth*, masticatory teeth; *mt-m‘t’*, median transverse suture; *Mth*, mouth opening; *Musc*, muscle bands; Nu_1, nucleus of muscle cell; Nu_2, nucleus of epithelial cell; *Oe*, oesophagous; *ObBr*, obstructing brush; *Phy*, pharynx; *PstPl*, posterior plate; *Pvent*, proventriculus; *Rdg*, ridge; *Sth*, sutural teeth; *Stom*, stomodaeum; *Str*, striae; *StrBr*, straining bristles; *Vent*, ventriculus.


Sth
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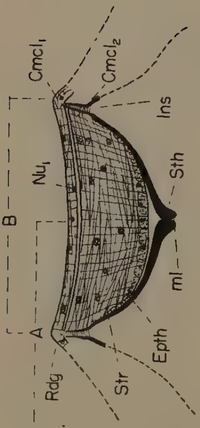
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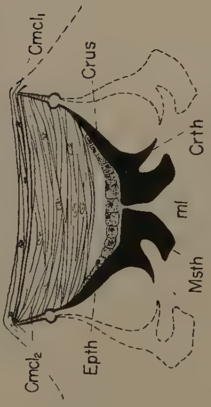
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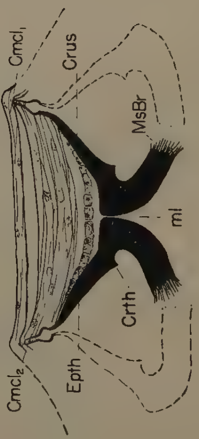
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Cmcl$_2$
Epth

7

HISTOLOGY OF THE PROVENTRICULAR WALL

The elements of the proventricular wall are illustrated in Figures 4, 5, 6 and 7. They consist of the outer layer of muscle fibres (*Cmcl*), the basement membrane, the much compressed epithelium (*Epth*), and next to the lumen the intima (*In*).

The intima extends from the mouth opening to the cardia, and although it varies considerably in thickness in various parts of the stomodaeum, it can be readily distinguished by its light brown color. In the pharynx and the oesophagous this layer is undifferentiated, but in the crop it possesess numerous short, stout prolongations of a spike-like character that are probably of use in manipulating food material.

The epithelial layer is made up of numerous reduced columnar cells. The walls of these cells are difficult to distinguish, but the nuclei and cytoplasm stain deep blue with haematoxylin. In the crop and anterior fore gut the epithelium is greatly reduced, but in the proventriculus proper this layer is fairly well defined, especially beneath the apex of the anterior plate. The cells here are typically columnar in shape and possess large dark-staining nuclei in which the chromatin network can be seen under high magnification. The function of this group of enlarged cells is not known, but it is suggested that they may act as glands secreting juices into the proventriculus through the bases of the apical teeth to aid in breaking down food material.

The muscle cells of the proventriculus are the most conspicuous elements in longitudinal and transverse sections. The bodies of these cells stain pink with Eosin, and the nuclei dark blue with the iron stain. There appear to be two bands of circular muscles: a narrow outer layer ($Cmcl_1$) that is continuous around the proventriculus, and a wider inner layer ($Cmcl_2$) that is divided into eight sectors by the longitudinal ridges of the proventricular plates. For *Pityogenes* Beal indicates a similar arrangement of the muscle fibres, although he considers the outer layer to be longitudinal muscle. In both of these cases, however, the two muscle layers run at right angles to the long axis of the proventriculus, thus it is difficult to say which layer corresponds to the longitudinal muscle generally found in other insects (Snodgrass, 1935). It is quite probable that modifications in function have necessitated the realignment, and for practical purposes it is considered that both layers act as circular muscles.

EXPLANATION OF PLATE II

Fig. 5. Cross section of the proventricular wall midway the anterior plate. ×76.

Fig. 6. Cross section of the proventricular wall in the cephalic part of the posterior plate, showing the structure of the anterior lamellae. ×76.

Fig. 7. Cross section of the proventricular wall in the caudal part of the posterior plate, showing the structure of the posterior lamellae. ×76.

Fig. 8. Longitudinal sector of the proventriculus showing the arrangement of the internal armature. The arrows indicate the course of food material passing from the crop to the ventriculus.

(See Page 45 for list of abbreviations used.)

FUNCTION OF THE PROVENTRICULUS

Ips radiatae feeds on plant cells obtained from the phloem region of the host in the form of minute strips of tissue. When this food is ingested it is passed into the crop where it is temporarily stored for a short period; thence it goes through the grinding-straining mechanism of the proventriculus and finally on into the ventriculus. Its passage through the proventriculus is probably restricted to the side channels formed by the rows of lamellae, since the obstructing brushes extending into the lumen would prevent direct movement of the food material through the central opening. The probable course of the food material along the channels is indicated by arrows in Figure 8. The lamellae of the posterior plate appear to be structurally suited for masticating plant tissue, and presumably this is their function. They may also serve as strainers, preventing coarse material from reaching the ventriculus. Recognizeable differences in particle size between the contents of the crop and the front part of the proventriculus as compared with the contents of the posterior region indicate this function. In the anterior region fragments of plant tissue are usually easily discernible, whereas in the posterior region the material is so finely ground that its origin is unrecognizeable.

SUMMARY

The proventriculus of the bark beetle *Ips radiatae* was found in this study to be a complex structure modified to perform the function of grinding and straining food material, which for this insect consists of woody plant tissue. An investigation of the internal structure of the proventriculus revealed that it was made up of eight heavily sclerotized units, each enclosing a food channel. Each unit was found to be transversely subdivided into two equal parts: an anterior region consisting of two smooth plates, toothed marginally; and a posterior region made up of two rows of double toothed lamellae. A detailed description is given of the armature of a typical segment.

Studies on the histology of the proventricular wall showed both muscle layers were transverse. The original longitudinal layer has apparently become rearranged to act functionally as circular muscle.

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THE GENOTYPE OF FORCIPATA

(Homoptera-Cicadellidae)

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Ohio State University

The genus *Forcipata* was described by the authors in 1936 (Ann. Ent. Soc. Amer. 29: 70). At that time nine new North American species were described in the genus but inadvertently the genotype was not designated. It was the plan of the authors to designate *loca* as the genotype in view of the fact that it is the most common and widespread species of the genus which occurs in North America. *Forcipata loca* DeL. & Cald. is therefore designated as the genotype.

THE DISTRIBUTION OF RADIOPHOSPHORUS IN WAX MOTH, MEALWORM, COCKROACH AND FIREBRAT[1]

Eder Lindsay[2] and Roderick Craig[3]
Division of Entomology and Parasitology
University of California

Few investigations on the fat metabolism of insects have been made, and generalizations from the processes in vertebrate animals involve the difficulties of the differences in morphology. There is, for example, no organ analogous to the liver. Some resemblances, however, are evident. The same fatty acids are partly formed, as in vertebrates, from carbohydrates and proteins, and the fatty acids of the diet are changed during deposition (Yuill and Craig 1937; Wigglesworth 1939.) During pupation, the unsaturated fatty acids are used first and the fat globules are associated with protein before being liberated into the body fluids (Bishop 1923). Further, cholesterol, at least in one insect, is an essential ingredient of the diet (Gay 1938). Phosphorus, too, is essential in the diet (Nelson and Palmer 1935), and its cycle in the digestive tract has been demonstrated in the bee (Hoskins and Harrison 1934) and in the mealworm (Patton and Craig 1939).

In the studies being made with vertebrate animals, radiophosphorus, P^{32}, is frequently used as a tracer element. We have extended this investigation to insects to find the distribution of the P^{32} in the tissues and to compare its fate with that in vertebrate animals.

METHODS

The insects used were wax moth, *Galleria melonella* L., larvae; mealworm, *Tenebrio molitor* L., larvae and adults; cockroach, *Blattella germanica* L., nymphs; and firebrat, *Thermobia domestica* Pack., adults. They were chosen from the insects available in the laboratory because of their biological differences and because they fed readily on the experimental diet. Cockroaches proved the most difficult to handle because they spent periods without feeding and because of their need for water.

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[1] Presented at the Conference on Applied Nuclear Physics held at Massachusetts Institute of Technology, Oct. 28 to Nov. 2, 1940.

[2] The work was carried out during the tenure of a research fellowship from the University of Melbourne, Australia.

[3] The authors are indebted to Dr. J. G. Hamilton and to Dr. A. A. Koneff for their advice on experimental methods.

The radiophosphorus, supplied through the courtesy of Professor E. O. Lawrence and the workers in the Radiation Laboratory, was fed as $NaH_2P^{32}O_4$ solution of activity 193 microcuries per c. c. on mixed grain meal. The insects were confined individually and as soon as an appreciable amount had been eaten, (in 1–3 days) they were removed to a fresh diet without P^{32}, and killed after various intervals. The amount of P^{32} consumed was of the order of 2 microcuries per gram of body weight.

The insects were quartered and alternate pieces were used for (a) Frozen sections, after gelatin imbedding and fixation in 10 per cent formalin; (b) Paraffin sections, after chloroform clearing and fixation in Susa's fluid. Both were cut about 10 μ thick.

Two other methods for retaining the fat in the tissues were tried and then abandoned. These were clearing in "Cellosolve," and fixing in osmic acid. The first dissolved the fat and the second made the tissues too brittle for successful sectioning.

The selected sections, serially arranged, were dried on glass slides, covered with a celloidon membrane and exposed to X-ray film. The grain size of this film did not affect the picture and the upper image of the double emulsion was reduced or scraped off. The exposure necessary was equivalent to 50 milli-microcuries per sq. mm. for one minute.

The paraffin sections were stained in haematoxylin and eosin (Craig and Wilson 1937) or by Koneff's triple stain (1936). The gelatin sections were stained with Scharlach R. and Harris' haematoxylin.

INTERPRETATION OF RADIOAUTOGRAPHS

There was a reaction between the film and radiations from the P^{32} over practically all the tissue. The areas of greater density were identified by superimposing the film on the appropriate section, before and after staining, and viewing with a microscope. Scatter radiation, which extended about 17 μ beyond the tissue, made difficult the identification of low concentration of P^{32} in small areas of tissue such as the malpighian tubules near the mid intestine, the salivary glands, and the epithelium of the crop and hind intestine. The smallest area in which P^{32} was considered as definitely present was 39 μ in diameter.

DISTRIBUTION OF RADIOPHOSPHORUS

The distribution of P^{32} in the sections is shown in Table I. Plate I shows some radioautographs with the appropriate stained sections. There was less P^{32} in the paraffin sections than in the frozen sections, but the relative concentration in the various tissues was the same.

Wax Moth.—Sixteen larvae were examined at intervals from 2 to 35 days after the P^{32} meal. The distribution of the P^{32} was the same in all (except that only in those killed within one day of feeding was it found in the intestinal contents). The greatest concentration was found in the epithelium of the mid intestine and silk glands and in the wing buds and gonads. It was found also in the nerve ganglia, the fat body, parts of the tracheal epithelium, the oenocytes near the mid intestine, the malpighian tubules around the hind intestine, and the muscles of the intestine and of the body wall. Both in the fat body and in the muscle, the P^{32} was sometimes more concentrated in small areas; but these did not differ in structure from the remainder of the tissues.

No P^{32} could be detected in the salivary glands, the hypodermis, the epithelium of the fore and hind intestines, nor the anterior region of the malpighian tubules.

In the paraffin sections the P^{32} was again most concentrated in the epithelium of the silk glands and mid intestine, and in the gonads and wing buds. However, it was not more concentrated in the muscles than in the fat body. It was rather more concentrated in the periphery of the sections. Here the fat is retained between the muscle and body wall and the lobes could not swell during the treatment as did those in the larger coelomic spaces. The cells are smaller, the nuclei closer together and the spaces left by the dissolved fat much smaller.

TABLE I

LOCATION OF P^{32} IN SECTIONS

	Wax Moth		Cock-roach	Fire-brat	Mealworm		
	Larva	Pupa	Adult ♀	Adult ♀ ♂	Larva	Pupa	Adult ♂
Fed P' meal, days	2	2	5	4	2	2	8
Fed no P', days	35	35	0	25	6	9	9
Fat	†	†	†	†	†	†	†
Oenocytes	†	....	....	....	....	....	....
Body muscle	*	*	....	....	*	*	*
Crop epithelium	‡	....	....	....	....	....	....
Gizzard muscle	†	....	....	†	....	....	....
Mid-int. epithelium	*	*	*	*	*	*	*
Mid-int. contents	‡	‡	†	‡	‡	‡	‡
Hind-int. epithelium	‡	‡	‡	‡	†	....	†
Hind-int. muscle	†	....	....	‡	....	....	....
"Rectal organ"	....	....	....	....	*	....	*
Mal. tubule	†	....	†	†	....	....	†
Salivary gland	‡	....	....	‡	....	....	....
Silk duct	*	....	....	....	....	....	....
Ganglion	†	....	....	†	....	†	....
Hypodermis	‡	*	‡	‡	‡	*	*
Access. reprod. ducts	....	....	....	†	....	*	*
Tracheal epith	†	....	....	....	....	....	....
Wing bud	*	....	....	....	....	....	....
Gonad	*	....	‡	‡	†	....	*

Key: * P^{32} concentrated. † P^{32} present. ‡ P^{32} absent.

Two insects pupated during the tests. These ate so little that they were left on the P^{32} meal for 10 days, and then killed within 12 hours of pupating, 11 days later. The P^{32} was concentrated in the large hypodermal cells, in the epithelium of the mid intestine and in the muscle. Some P^{32} was present also in the fat body. Frozen sections only were examined.

Cockroach.—Only one insect was examined and paraffin sections were used. The P^{32} was concentrated in the epithelium of the mid intestine. It was present also in the malpighian tubules and reproductive ducts, but none could be detected in the testes.

Radiophosphorus
Eder Lindsay and Roderick Craig

PLATE I

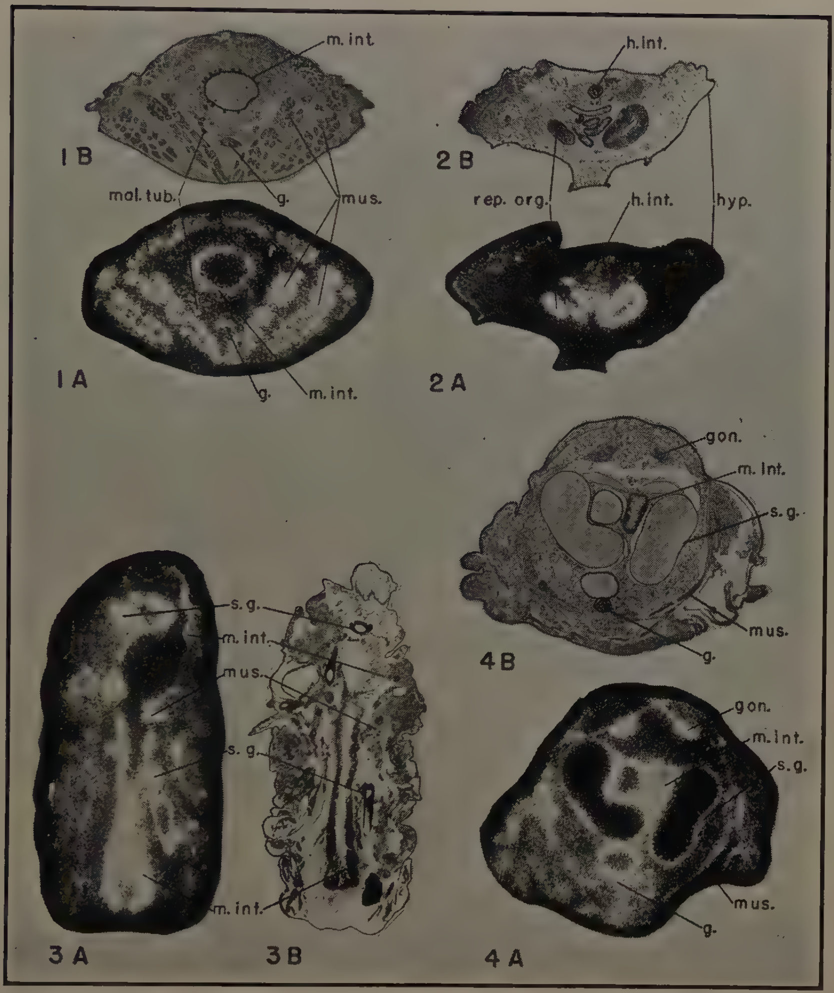
m. int
1 B
mal. tub.
g.
mus.
1 A
g.
m. int.
h. int.
2 B
rep. org.
h. int.
hyp.
2 A
gon.
m. int.
s. g.
mus.
g.
4 B
s. g.
m. int.
mus.
s. g.
m. int.
3 A
3 B
gon.
m. int.
s. g.
mus.
g.
4 A

Fig. 1. Radioautographs (A) and corresponding stained sections (B). × 8. White areas in radio autographs are exposed parts of film.

1. T. S. Thorax Mealworm adult, paraffin section.
2. T. S. Abdomen Mealworm adult, paraffin section.
3. L. S. Abdomen Wax Moth larva, frozen section.
4. T. S. Abdomen Wax Moth larva, frozen section.

g, ganglion; *gon.*, gonad; *hy.*, hypodermis; *mal. tub.*, malpighian tubule; *m. int.*, mid intestine; *mus.*, muscle; *h. int.*, hind intestine; *rep. org.*, reproductive organs; *s. g.*, silk gland.

Firebrat.—Four insects were examined at intervals of 1 to 25 days after feeding. The P^{32} was most concentrated in the walls of the spermatheca and vas deferens, and in the testes. In this insect as in the wax moth larvae, the concentration in the nerve ganglia was lost in the paraffin treatment.

Mealworm.—Two larvae, a 5-day old pupae, and a newly emerged adult female were examined. In the larvae the P^{32} was concentrated in the mid intestinal epithelium and in the muscles. It occurred also in the young ovaries and in the "rectal gland."

In the pupa, the P^{32} was concentrated in the hypodermis and peripheral fat. It occurred also in the ova, reproductive ducts and nerve cord.

In the adult which had developed from one of the larvae fed on the P^{32} meal, the amount of P^{32} was not reduced by the paraffin treatment. It was concentrated in the epithelium of the mid intestine, in the reproductive ducts and ova, and in the hypodermis of the genitalia and body wall, particularly on the ventral side. There was also great concentration in the leg muscles, but in the large dorsal wing muscles there was a slight concentration in the frozen sections only. In the malpighian tubules the concentration was high in the region of the "rectal gland," in both sections. There was also a slight concentration in the anterior region of the tubules in the frozen sections. The cast skins of the last larval instar and pupa were also found to contain P^{32} even after washing for 5 hours in water and alcohol. This treatment hardly affected the amount of P^{32}, and there was more in the larval than in the pupal skin.

DISCUSSION

The distribution of P^{32} in the sections after the two methods of preparation, indicated the types of compounds in which it was located. In the frozen sections, presumably only the water soluble phosphorus was lost and the P^{32} was present as phospholipids, phosphoproteins, hexose phosphates, phosphoglyceric acid and adenyltriphosphoric acid. In the paraffin sections probably only the phosphoproteins were retained.

From analogy with the condition in vertebrate animals, the epithelium of the mid intestine seemed to be the only tissue concerned with the mobilization of fat, and the high concentration of P^{32} there suggested that this was effected through phosphorylation.

In the fat body, the low concentration in the frozen sections and the relatively higher concentration in the paraffin sections suggested that the P^{32} was present mainly as phosphoproteins. If phospholipids are important in the mobilization of the neutral fat, they must be removed as fast as they form.

In the newly formed tissues such as the gonads and wing buds, the high concentration in the paraffin sections showed that the P^{32} was present as phosphoproteins. This was evident, too, in the young adults which had been fed the P^{32} while still larvae. It is suggested that this is analagous with the concentration in tumor tissue, (Tuttle).

The high concentration of P^{32} in the epithelium of the mid intestines and silk glands may be associated with the greater activity of these tissues. It is interesting to note that the cytoplasm of all these tissues stained heavily with haematoxylin. There was no material present which stained with Scharlach R. Fischler's method for fatty acids was not tried since it would not stain phospholipids. The dorsal muscles of the newly emerged adults stained very little with the haematoxylin and contained no P^{32}. These differences from the leg muscle may be associated with the fact that the wing muscles had been used little if at all before the insect was killed.

The high concentration in the malpighian tubules where they form the "rectal gland" is interesting in view of the fact that Patton and Craig showed an uptake of phosphorus from this region of the gut.

The appearance of P^{32} in the nerve cord in both the paraffin and frozen sections was interesting because of the low concentration in the brain of vertebrate animals, and may be associated with the probable absence of the myelin sheath in insects.

The fact that the P^{32} was evident in the cast skins but not in the cuticle of the sections may be due to a later deposition or to the fact that the concentration was too low to show in the sections.

SUMMARY

The distribution of P^{32} was followed in the larvae and pupae of *Galleria melonella*, L., larvae, pupae and adults of *Tenebrio molitor*, L., and in adults of *Thermobia domestica*, Pack, and *Blattella germanica*, L. Frozen sections and paraffin sections were used to obtain the radioautographs. In all the insects, the P^{32} was least concentrated in the fat body, and most concentrated in the epithelium of the mid intestine, in the reproductive ducts and in the gonads. It occurred also in the muscle, nerve ganglia, and malpighian tubules, but little or none was present in the salivary glands or in the epithelium of the hind and fore intestines.

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CIRCULATION OF HEMOLYMPH IN THE WINGS OF THE COCKROACH, BLATELLA GERMANICA L.

II. Effects of Cutting Hemolymph Channels in the Normal Tegmen and Hind-Wing

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The first paper (1) of this series presented a detailed account of normal paths of circulation in wings of the roach, *Blattella germanica*. The following report describes changes in hemolymph currents set up when normal pathways are eliminated or altered by cutting away parts of the wing, or by direct section of one or more channels. Search of available literature did not reveal a single paper dealing with this particular phase of regulatory and compensatory hemolymph flow in insect wings.

Terminology, materials, and methods are those listed in investigations of normal circulation (1, 2). Small scalpels made of bits of razor blades served to cut through internal channels, while small well-sharpened dissecting scissors were used for cutting across or through margins of wings.

In this paper, the term "sectioning," for the most part, refers to cutting completely or partially across a wing, through at least one margin. On the other hand, "severing" is used to describe internal cuts across hemolymph channels without cutting through wing margins.

Results

The following results are presented as the circulatory adjustments most often encountered during the experimental studies. It will be remembered that there is considerable individual variation in normal wing circulatory patterns (1, 2). The same is true for many compensations established when channels are cut or sectioned. Only the more important and essential adjustments are reported and diagrammed. For the most part they involve major hemolymph channels. With the large number of channels present, obviously many other sections and cuts could be made. Many additional operations were performed, but to describe them would lead to detailed and unnecessary repetition.

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A. TEGMEN

1. Sectioning to remove apical area. Cuts such as indicated in figures 1A and 1B force the transitional area, in which afferent currents become efferent, to shift closer to the body, nearer the base of the wing. A section passing through the area of origin of the R_s, extending from costal to inner wing margin produces no marked changes if the channel which ordinarily transfers the hemolymph from radius to medius is not destroyed. Costal hemolymph flows through costo-radial cross channels to the radius, and, with the radial stream, passes into the medial channel. Currents in medial and cubital areas proceed normally, but frequently some ordinarily inactive channels become functional.

2. Cuts through medial and cubital channels. If the cut passes from the inner margin through both cubitals and all medials, as in figure 1C, distal costal and costo-radial hemolymph swings back through R and R_s, enters the proximal remigial zone, and then proceeds as usual. Distal medial circulation is stopped. If only medials are interrupted, as in figure 1D, distal medial circulation is retained. The returning fluid flows to the margin of the cut, percolates toward the inner edge, and goes into cubito-postcubital cross-channels.

3. Cuts through cubito-postcubital channels. Effects from these cuts are not figured since circulation in the entire remigium simply ceases. There is now no way for returning efferent hemolymph to enter the vannal area. Streaming in the vannals may also stop unless a secondary hemolymph circuit from axillary into vannal channels is set up. Such a circuit sometimes occurs, even normally.

4. Longitudinal cuts, parallel to the radius. If mutilations of this type extend all the way across, above the radius, to the wing base, costal circulation will cease because there are no outlets for its volume. Radial currents below the cut proceed distally in the customary manner. If the cut is below the radius, as in figure 1E, afferent flow above it will stop, but that in the medius continues. When the longitudinal slash is below the medius, afferent flow is shifted farther down into cubitals. From them it goes directly into vannals by way of cubito-postcubital paths.

5. Severing vannal channels. Figure 2 is self-explanatory in showing results from cuts in the vannal area. Figure 2A depicts the most active normal efferent currents as well as the subsidiary afferent vannal flow which sometimes is normally present. If vannals are progressively severed, as in B, C, and D of Figure 2, efferent hemolymph is merely diverted above the cut and is redistributed to proximal vannal pathways. If all vannals are severed, as in figure 2E, efferent flow usually continues as shown so long as the postcubital exit remains intact. When the postcubitus is included in the gash, circulation stops because the normal efferent outlet has been obliterated.

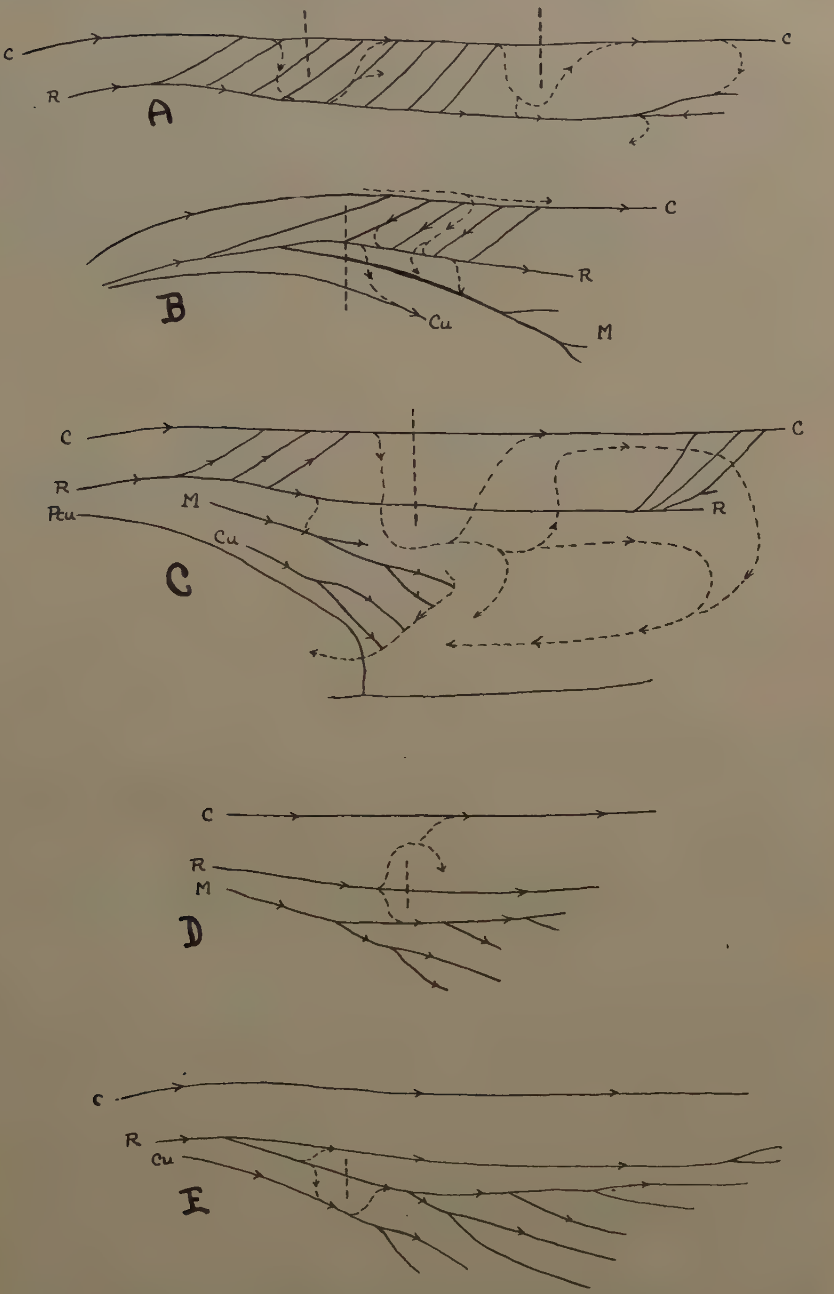

Fig. 1. Diagrams showing effects on circulation of cutting hemolymph channels in the tegmen of *Blattella germanica:* *A* and *B* show sections which remove the apical area. *C* indicates changes when the cut passes through the medial and cubital channels. If only the medials are severed, the directions of flow are as in *D*. When a longitudinal cut is made parallel to the radius, the hemolymph currents shift as in *E*.

cf Vol. 35 p. 478.

6. Cutting cubito-postcubital cross-channels. Figure 3A shows normal relationships between vannal and postcubital channels in an intact tegmen. If the two lower cross-channels are cut, as in 3B, the remaining Cu-pcu channels will take care of remigial outflow. If all Cu-pcu pathways are eliminated, as in 3C, remigial flow stops; but vannal circulation continues because of the secondary vannal circuit. In this alternate scheme, afferent hemolymph enters upper vannals, flows to post-cubitus, becomes efferent, and returns to the hemocoele through lower vannals. Figure 3D shows a vannal area in which vannal afferent currents were absent until the Cu-pcu cross-channels were sectioned. Afferent currents then began and continued as long as the specimen was under observation.

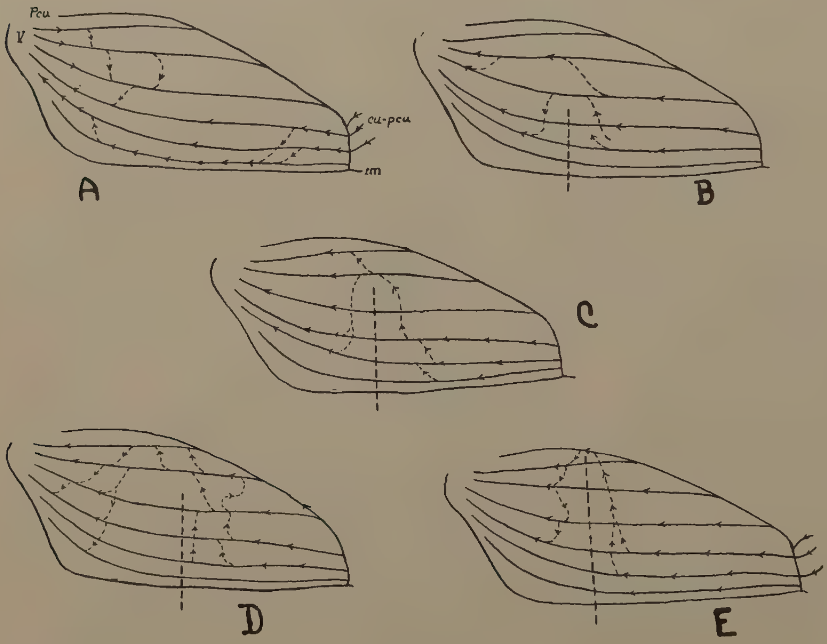

Fig. 2. Diagrams showing hemolymph circulation in the vannal area of the tegmen: In *A* are found the directions of the most active normal efferent currents, as well as subsidiary afferent flows sometimes present normally, and often initiated when the main remigial circuit has been eliminated. Changes in currents brought about by cutting some or all vannal channels are shown in *B*, *C*, *D*, and *E*.

7. Severing separate channels within the interior of the wing. In these experiments one or two main hemolymph passages were destroyed. A few of the more important compensatory flow-patterns are sketched in figure 4. Usually, distal regions are not altered much by severing individual passageways—unless the pathway be in the cubito-postcubital area. In general, resulting situations are as given below, when the following channels are cut:

a. *Costal.* If the costa is cut proximal to fusion with the subcosta, there are no marked changes since the latter channel simply takes over the entire afferent volume. If the costa is cut at places such as indicated in figure 4A, some adjustment in costo-radial cross-channels is initiated, but no radical changes occur. Cuts through the costa in the distal intermediate remigial zone may stop circulation in the remaining part of the costal channel.

b. *Radial.* When the radius is cut near its base, flow in the first three or four costo-radials is reversed, and radial currents proceed as in 4B, where medius and cubitus are included in the cut. Figures 4C and 4D show variations of the above situation.

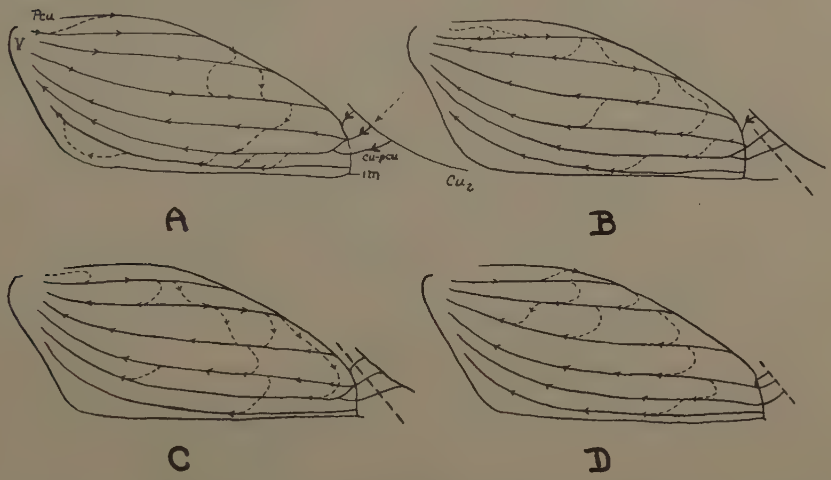

Fig. 3. Diagrams to show relationships between vannal and postcubital channels of the tegmen: In *A* is sketched the normal circuit (including a subsidiary afferent flow). *B*, *C*, and *D* show changes initiated by severing some or all of the cubito-postcubital cross channels which bring remigial hemolymph into the vannal area.

c. *Medial.* Results from cutting the medial channel are diagrammed in figure 4E. Medial hemolymph is diverted into the cubital channel, and then returns to the medius beyond the interruption.

d. *Cubital.* When the cubitus is cut near the base, medial hemolymph passes into cubital channels distal to the cut, and follows a normal course.

e. *Vannal.* If a single vannal pathway is cut, the current enters neighboring channels on either side and continues on its way.

f. *Axillary cord.* Hemolymph returning to the hemocoele passes through the jugum. If the axillary cord is cut near the tergum, circulation stops, for there is no other way by which efferent fluid may leave the wing. When the cord is cut nearer the jugal fold, secondary channels may carry the flow around the cut, but the volume of flow seems to be considerably reduced.

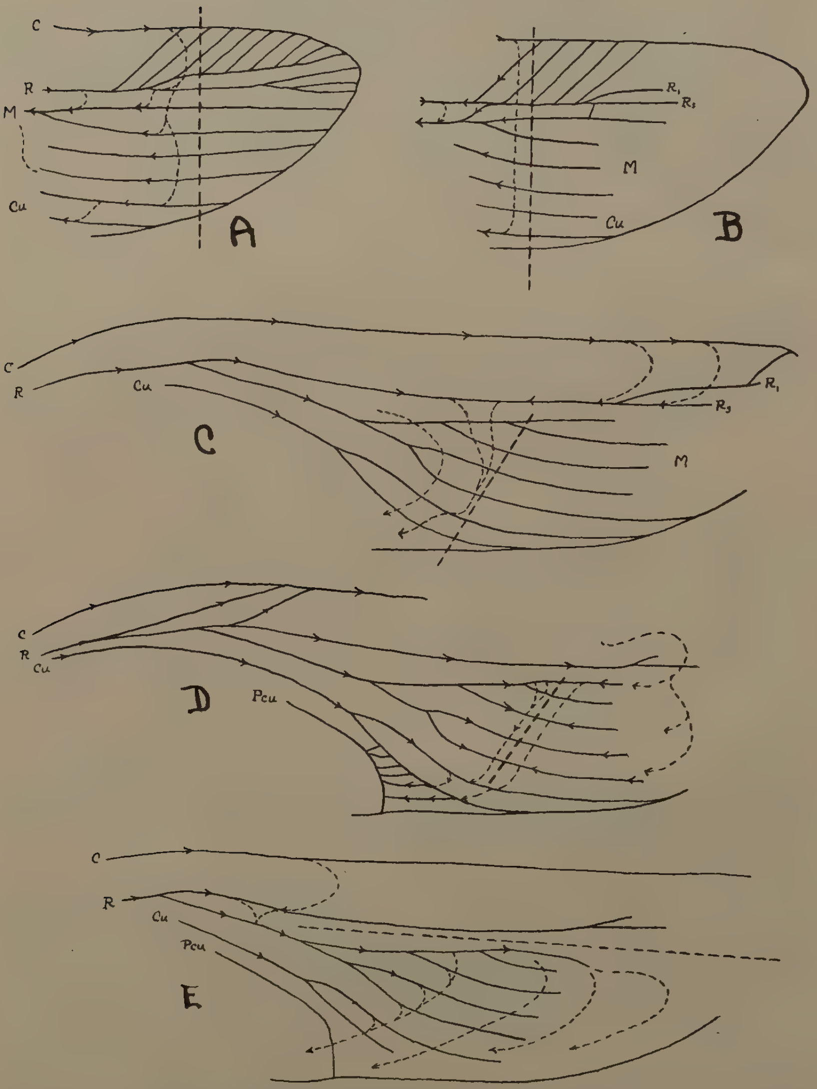
C
R
M
Cu
A
R_1
R_s
M
Cu
B
C
R
Cu
C
R_1
R_s
M
C
R
Cu
D
Pcu
C
R
Cu
Pcu
E

Fig. 4. Diagrams showing changes in the circulatory pattern of the tegmen after one or more separate channels are cut: *A* shows cuts through the costal margin; *B*, through the radius, medius, and cubitus; *C*, through costa and radius; *D*, through the radius alone; and *E*, through the medius only.

B. HIND-WING

Alterations and compensations in flow in the hind-wing are, in general, quite similar to those set up in the tegmen. Consequently, results with the hind-wing will not be outlined as above. Essential observations are summarized below.

Sections commencing at the apex of the wing and progressing proximally, almost to the base of the wing, may be cut away without stopping circulation. This is because the postcubitus of the hind-wing is not a barrier to cross-flow, as it is in the fore-wing. Just as in the tegmen, longitudinal cuts above the cubitus do not stop circulation. When cuts are located along or just below the vena dividens, secondary vannal circulation becomes more active and carries a greater volume of hemolymph. The remigial flow is not stopped by this cut, however, until it enters the base of the wing where the gash often interferes with vannal flow.

Cutting of separate channels of the hind-wing brings about changes which are, in general, similar to those already outlined for the tegmen. However, there is one prominent difference. Severing of cubito-postcubital cross-channels does not stop remigial flow from entering the vannal area. Entry of remigial efferent flow is over a more extensive area and involves more channels in the hind-wing than in the fore-wing (1, 2). To stop circulation entirely in the hind-wing, slashes must be close to the base of the wing in the region just distal to the third axillary. It must include the Cu_2 and postcubital efferent passages into the jugal area.

C. GENERAL OBSERVATIONS

After hemolymph flow has been completely and permanentlystopped in either wing of this cockroach, the appendage loses much of its flexibility. Within a short time it becomes dry, brittle, and may curl and twist. Fore-wings with secondary vannal circulation persisting after the remigial circuit is stopped, break away easily along the vannal fold. Under such circumstances, the vannal area undergoes no perceptible change in appearance or texture.

Gas bubbles often occur in wings without circulation. These pockets of gas lie within the channels. Their source is not known. They may come directly from nearby tracheae, or from breakdown alterations of non-circulating hemolymph. At least, these bubbles seem to indicate some interference with normal gaseous exchange in the wing.

Frequently there is an obvious change in the structure of the tracheae themselves. Sometimes the tubes in wings lacking circulation will collapse; sometimes they seem to draw up, become convoluted, and pull back in the direction of their larger diameter.

Specks of reddish pigment often appear in wings in which there is no circulation of hemolymph. These dots of concentrated color are rarely seen in normal wings. Their origin and significance are not known.

When main hemolymph channels are oblitered or interrupted, rate of flow through alternate or secondary channels is often accelerated. In many cases these alternate by-passes are not even visibly functional until the volume from the main channels is diverted into them. These secondary pathways serve to alleviate the damage of impaired circulation.

DISCUSSION

When circulatory patterns established by the above experimental procedures are compared with the usual scheme (1, 2) of hemolymph flow in wings of *Blattella germanica*, a better understanding of normal circulation in the tegmen and hind-wing evolves. Passage of hemolymph into and through this insect's wings is not a haphazard overflow from the hemocoele into wing channels. The unaltered wing circulation presents a pattern which is quite stable in its larger channels, and when that pattern is disturbed, readjustments are quickly made so that the new scheme will conform as closely as possible to the normal pattern and, at the same time, continue the usual functional demands. If the disturbance is serious, adjustment responses may be surprisingly radical in order to re-establish as much circulation as possible under the prevailing conditions. Interruptions of flow at right angles to veins cause the zone of transition-flow from afferent to efferent to shift nearer the base of the wing, and thus closer to the body. Circulation within the tegmen is not completely arrested until sections pass through cubito-postcubital channels. These channels provide the only path in the wing for remigial volume to reach vannal area pathways. If these Cu-pcu channels are destroyed, there is no other way by which hemolymph can return to the hemocoele. In the hind-wing, conditions are different. Cutting cubito-postcubital channels will not arrest circulation. In fact, circulation may continue until a separating slash reaches the base of the wing.

Frequently secondary paths of circulation are set up in wings when the usual channels are eliminated. Hemolymph from the axillary region may pass into the vannal area through the basal fold in this region. Such hemolymph would ordinarily pass first through the remigial region before reaching the vannals, but now has been diverted to basal fold currents. This manner of adjustment prevents drying up and destruction of the base and vannal area of wings, should remigial flow be arrested. The area of remigial circulation, alone, can be eliminated without serious results, but if the base were to dry up and crack, serious obstacles to movement of hemolymph would be set up. When remigial flow is stopped, the basal fold route is essentially the same in both hind-wing and tegmen. However, experimental arrestation of remigial circulation in the hind-wing is more difficult. When it is achieved, secondary circulation begins, as in the tegmen.

Complete longitudinal cuts, more or less parallel to larger veins and extending to the wing base, usually stop circulation above the interruption; below, normal routes are maintained until the last afferent channel is destroyed, provided the wing base is not mutilated. Circulation then stops unless certain normally efferent channels become afferent, and establish a secondary circulation.

The importance of single hemolymph pathways in maintenance of the general pattern of wing circulation may be demonstrated by severing individual channels. For example, if the radial channel is severed near the base so that radial streaming stops, the scheme of circulation is considerably altered. Often the radial current is reversed, but does not stop. Costal hemolymph crosses at the distal end of the radius and flows efferently to the cut where it is diverted into medial streams.

Sometimes cross channels may allow afferent currents from the media or costa to enter the radius distal to the cut. Again, if currents are interrupted by severing medius or cubitus at the base, afferent flow usually stops. Flow in the efferent section of these channels then proceeds farther proximally than usual. If afferent hemolymph flow is maintained after cutting media or cubitus, its source is from the radius.

Remigial channels of both wings act similarly, but there is some difference in the postcubital—vannal fold area. In the hind-wing, some of the remigial hemolymph flows efferently from the extremity at the outer margin of the wing along Cu_2, Pcu, and vena dividens. This efferent volume either empties into the bases of the-vannals and initiates secondary afferent vannal currents, or flows directly through the jugum to the pulsatile region. If the stream sets up a secondary pattern in the vannals, its origin is different from the secondary currents observed in the tegmen. In the latter wing the source is from the axillary region, hence directly from the hemocoele, and not from the remigium as in the hind-wing. This hemocoele source likewise often occurs normally in the hind-wing, in which case the volume combines with that of the remigial source. When bases of Cu_2, Pcu, and vena dividens of the hind-wing are destroyed, the only currents from remigial to vannal area are in cross-channels between postcubitus and vannals. These basal cuts establish a complete cubito-postcubital escape of remigial hemolymph, identical to that in the normal intact tegmen. Severing the Cu-pcu cross-channels will then usually arrest hind-wing remigial flow.

Severing vannal channels in either wing produces minor changes. Such cuts force a transfer of hemolymph to the next vannal, either above or below, or both. In the tegmen, various channels were severed in an attempt to induce circulation in the postcubital channel which normally does not participate in transmitting hemolymph. None of the attempts gave complete success. Sometimes circulation occurred in the distal area, but never along the entire length of the channel. There may arise some forced proximal flow, but this will be a cross-wise stream from the basal fold, as this hemolymph passes along to vannal channels.

SUMMARY AND CONCLUSIONS

1. Hemolymph circulation in wings of *Blatella germanica* follows rather well established patterns whose directions are maintained as closely as possible when usual routes are disrupted. Minor passage-ways which transport small volumes of hemolymph are quite variable and allow fluid to percolate and meander through the smaller tissue spaces. Larger volumes, however, are not carried by random channels. The latter are confined to definite regions marked off by the anatomical structure of the wing and its veins.

2. Distal sections made at right angles to main channels, and extending through at least one margin of a wing, bring about readjustments which shift the intermediate afferent-to-

efferent transition zones closer to the body, and thus farther from the apex of the wing. These cuts may or may not arrest circulation. If cross-channels are present, or if secondary currents are established, circulation will continue until a cut reaches a vital region such as that of the cubito-postcubital channels of the tegmen.

3. Longitudinal cuts from the apical margin of the wings, parallel to main hemolymph channels, stop circulation above the slash if it extends completely to the base of the wing. Below the cut, circulation will proceed in a more or less regular manner, provided afferent currents are present. If parallel cuts extend only part way into the wing, the out-going volume above the cut proceeds toward the apical margin, percolates downward, reverses its direction just above the cut, and returns in the efferent direction until it comes to the end of the cut. The hemolymph then moves afferently below the cut or continues in regular efferent channels.

4. Cuts across one or main channels within the interior of the wing, force hemolymph to pass around the cut, and frequently bring about reversal of flow in neighboring afferent channels, especially if the interruption is in the radius. In general readjustments after cuts of this type are not so apparent or widespread as those initiated by cutting across the wing. If a single channel is cut, the current merely becomes diverted to passages above and below, then proceeds in a normal direction.

5. Although the general pattern of costal afferent flow and vannal efferent circulation is similar in both wings of this insect, the experiments described above have served to emphasize minor differences in details of circulation in tegmen and hind-wing of the German cockroach. Cubito-postcubital cross-channels are not functionally equivalent in the two wings. Severing these routes will arrest remigial circulation in the tegmen, but not in the hind-wing. In the latter appendage, there is one other means by which remigial hemolymph volume enters the vannal area; namely, hemolymph from the base of Cu_2, Pcu, and vena dividens. This additional outlet is absent in the tegmen. When cubito-postcubitals are eliminated there is no other way for remigial hemolymph to leave the fore-wing.

6. Aside from the secondary vannal source from the remigium of the hind-wing (Cu_2, Pcu, and vena dividens), additional secondary volume comes directly from the hemocoele

(basal fold channel). The latter source appears in nearly all normal hind-wings. The two secondary volumes usually combine in the proximal section of the hind-wing vannals and flow afferently. The basal fold current is the sole source for the secondary afferent flow in the tegmen, and is often present in the vannals of the normal tegmen. Severing the Cu-pcu channels is an almost infallible method of producing these currents in the tegmen when not normally present in a specimen.

7. Parts of a wing deprived of circulating hemolymph become dry and brittle, and very often crack away. It is plainly evident that the internal fluid is necessary to keep the wing tissue in good condition.

8. Other abnormalities appear in wings without circulation. Tracheae collapse, become coiled, and pull back in the direction of their attachment. Gas bubbles make their appearance among tissue spaces. Specks of reddish pigment may be found in wing areas deprived of hemolymph. Such changes as listed may be signs that respiratory and metabolic activities have been altered, and that physiological equilibria have been locally upset. Hemolymph circulation in the wing plainly serves purposes other than transport of water and nutriment to the inter-membrane tissues.

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REVISION OF THE NORTH AMERICAN MOTHS OF THE FAMILY OECOPHORIDAE, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES, by J. F. GATES CLARKE. Proc. United States Nat. Mus. 90: 33–286, pls. 1–48. Published by the SMITHSONIAN INSTITUTION, Washington, D. C.

The author gives us a painstaking review of a family of small obscurely colored moths, some of which are of economic interest. The forty-eight plates display heads and palpi, venation, male and female genitalia. It covers 22 genera and 117 North American species. A page of acknowledgments indicates the extent of the study necessary before publication.

Mr. J. F. Gates Clarke was educated at Washington State College, Pullman, Wash., then at Cornell University, where his interest in Lepidoptera was guided by Dr. Wm. T. M. Forbes. At present he is on the staff of the U. S. Bureau of Entomology and Plant Quarantine in the Division of Insects, National Museum.

—C. H. K.

ON THE FORMATION OF THE TRACHEAL FUNNEL IN ANASA TRISTIS DeG. INDUCED BY THE PARASITE TRICHOPODA PENNIPES FABR.

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The squash bug, *Anasa tristis* DeG., is commonly parasitized by a tachinid fly, *Trichopoda pennipes* Fabr. Within the body cavity of the host the parasite spends its three larval instars, the first of which may be found free in either the thoracic or abdominal cavity of the bug. Prior to the first molt, the maggot makes its way to the thorax, if not already there, and attaches itself to a tracheal trunk of the host with the result that its own tracheal system, through its posterior spiracles, has direct access to an adequate oxygen supply. Of 309 recorded cases, 304 were attached to metathoracic tracheae, on either the right or left side. The other five were connected to tracheae leading from the mesothoracic spiracles.

The precise mode of attachment is not known. The larva does not possess posterior hooks as are frequently found in other tachinid larvae and which supposedly serve this function of attachment, but numerous integumental spines do surround the posterior stigmata. These spines are extremely minute but should be adequate to secure the maggot to the tracheal wall of the host. Pantel (1910) noted that *Hyria tibialis* attaches itself to a trachea by first embedding itself in a lobe of the fat body and in contact with the trachea, at which point the irritation caused by a "recoiling" movement perforates the tissue of the latter. The larva of *T. pennipes* does not do this, but undoubtedly the thoracic musculature of the bug gives the parasite support while the posterior attachment is being made.

The ability to attach itself to a host trachea is not confined to a first instar parasite as was shown experimentally. By using a surgical technique, a second instar larva was dislodged from its tracheal connection. When the bug was dissected five days later, the maggot was found to be in a healthy condition and to have formed a new attachment to a different trachea.

THE TRACHEAL FUNNEL

The puncture of the trachea by the parasite induces a reaction of the host tissue to form a sclerotized funnel-shaped sheath around the posterior end of the parasite. This is comparable to that formed by other hosts attacked by tachinids and is the "gaine de fixation secondaire" of Pantel (1910), who described it as an outgrowth of the tracheal wall and composed of a thick inner layer of "chitin" and an exceedingly thin outer layer of hypodermis.

Several experiments on the squash bug confirm the observations of Pantel that the funnel is actually derived from the tracheal tissue, and that haematocytes play a negligible role. In each of several bugs a cactus spine was inserted through the second abdominal spiracle into the body cavity. This necessarily punctured the trachea. The bugs were dissected at intervals, and it became obvious that a sclerotized sheath completely surrounded the portion of the spine within the bug and in some cases engulfed normal trachea adjacent to the spine. Cactus thorns introduced into the body cavity free from any hypodermal tissues became irregularly discolored and occasionally had patches of cell films around them, but no sclerotized nor melanized sheaths were formed. Such spines remaining in contact with the body wall at the point of insertion or with injured tracheal vessels induced abnormal sclerotized tissue.

Following Eckstein's (1931) technique, live larvae of *Drosophila melanogaster* were introduced into the body cavities of squash bugs. The larvae, of course, died and became discolored, but they did not become surrounded by host tissues. Second instar larvae of *T. pennipes* killed in boiling water were introduced into the body cavity of the squash bug. In no case was a complete sheath formed around the foreign body—even one remaining six weeks. In some cases, however, irregular patches of tissue formed by an accumulation of cells of the haemolymph appeared on the maggot. These patches were in no way comparable to the encapsulation of parasites by the so-called phagocytic reaction nor to the sclerotized tissue of the tracheal funnel.

Pantel (1910) compared the sheath formed around the parasite *Winthemia* with an epithelioma of vertebrate tissues. The comparison is an apt one for the form under discussion, for the growth of the funnel in the squash bug is in no sense a teleological attempt on the part of the host to engulf the parasite. The tracheal attachment, as such, of the parasite is not permanent. As soon as the funnel surrounds the posterior one or two segments of the maggot, continued growth thrusts the parasite away from its original connection (see figure 1). Such a condition differs from the cactus spine mentioned above, which became completely enclosed, in the fact that the spine was firmly anchored to the body wall, whereas the parasite is free except for the connection with the funnel. Moreover, the connection of the parasite to the mouth of the funnel is not intimate and can be broken with ease and without injury. In fact, evidence suggests that the maggot is held within the sheath purely by internal hydrostatic pressure of the bug.

STRUCTURE AND GROWTH OF THE FUNNEL

Histologically, no region of mitotic activity has been observed in the preparations made of the funnel, the tissues of which resemble those described by Pantel (1910) as forming around *Ceramasia rufipes.* In spite of lack of cytological details indicative of growth, evidence shows that both longitudinal and radial growth occur concomitantly, and in no localized area. The extension of the maggot away from the tracheal vessel is proof of the longitudinal growth. The radial growth is regulated by the form of the maggot, the diameter of the funnel increasing in conformity with the developing maggot. Thus the funnel-shape of the sheath is not inherent in its formation, but becomes so only as the growth of the sheath parallels the growth of the parasite. The occasional presence of the exuvia of an earlier instar embedded in the sheath indicates that at the time of circumfluence, growth occurred at the distal margin of the sheath. More commonly, the cast skin of first or second instar larvae are found between the maggot and the enclosing funnel. The position of an embedded exuvia in relation to that of the maggot and experiments mentioned below suggest that growth is not limited to the distal area of the funnel but extension occurs along the entire axis. Undoubtedly, however, growth must be most rapid in the distal areas to account for the characteristic shape of the sheath. In any case, only the posterior end of the maggot becomes enclosed.

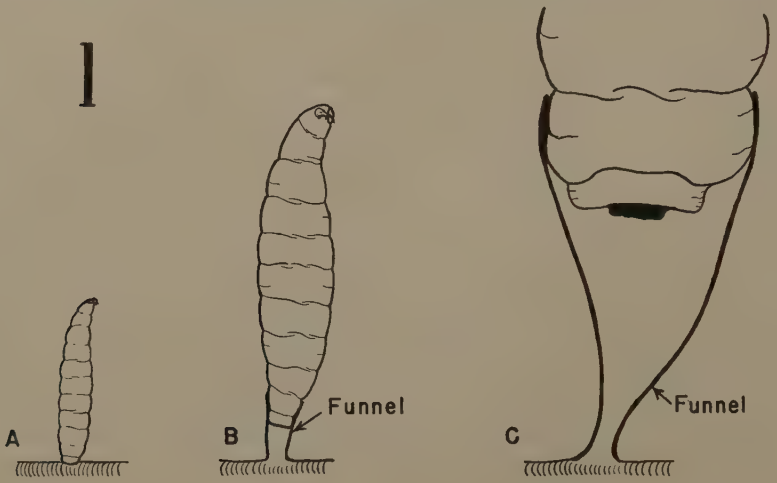

Fig. 1. Diagram showing connection of parasite larva to tracheal vessel of host. A. First instar larva attached to tracheal wall directly. B. Second instar maggot displaced from direct tracheal attachment by growth of funnel. C. Portion of third instar maggot in mouth of funnel, still further from tracheal wall.

Normally, the growth of the funnel continues until the parasite emerges and the host dies. To determine whether or not growth might be unlimited, attempts were made to kill the parasite in place without injury to the host. The operation is difficult and in only three cases were the results in any way successful. An abdominal incision was made in the bug, and the anterior end of the maggot, which was in the second instar, was pinched with forceps. The bugs were dissected at intervals after the operation, when the shape and size of the funnels were as illustrated in figure 2. Each funnel is illustrated in two planes, the difference being a 90° rotation. In B, the host was dissected 8 days after the operation; the parasite was dead and new tissue had been formed at the base of the sheath. The maggot was larger than the one enclosed by sheath C, which accounts for the larger diameter in B. C represents the sheath in a bug dissected 17 days after the operation. The maggot had not been killed, but its development had been inhibited; the sheath, on the other hand reached an abnormal length—being at least three times as long as the parasite itself. In neither case were more than the posterior two segments of the parasite ensheathed, thus emphasizing the conclusion that longitudinal growth of the funnel thrusts the maggot away from its original tracheal attachment instead of engulfing the foreign object. In A, the host was dissected 25 days

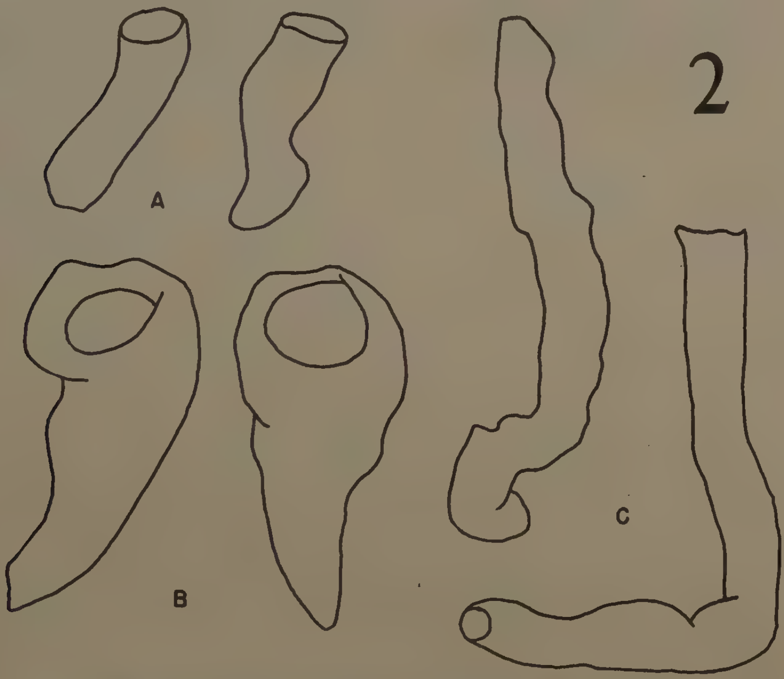

Fig. 2. Funnels formed in *A. tristis* under experimental conditions: A. Parasite killed in host and dislodged from tracheal sheath. Host dissected 25 days later. B. Host dissected 8 days after parasite was killed in place. C. Host dissected 17 days after operation similar to B, except that parasite did not die, although growth was inhibited.

after the operation, but the parasite, though dead, was found to have been dislodged from the funnel. It appears that this sheath ceased growth upon removal of the parasite. This observation is confirmed by two other similar cases, and by four cases in which a third instar parasite was surgically removed from the host. In no case was the sheath observably larger at the time of dissection than it should have been at the time of the operation, even though in one instance a period of 12 weeks elapsed. In one of the bugs from which a third instar parasite was removed, a portion of the gut completely filled the funnel, thus suggesting that hydrostatic pressure forced the tissue into the space left by the invading organism. In two others, the funnels were filled with a homogeneous, structureless substance having the appearance of coagulated body fluids.

Although with the technique employed, the cytological details of the hypodermal layer of the sheath are not clear, the nature of the tissue and its formation resembles that of wound healing in the insect integument as described by Wigglesworth (1937). It is here suggested, on the basis of the work done to date, that the funnel is nothing more than wound tissue, the growth and form of which is determined by the parasite acting as a mechanical barrier to the normal healing of the injured tracheal vessel.

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A REVISION OF THE STREPSIPTERA WITH SPECIAL REFERENCE TO THE SPECIES OF NORTH AMERICA, by Richard M. Bohart. Sixty-six pages, 8 pages of figs., 1 pl. Published by University of California Press, Berkeley, Calif., as Vol. 7, No. 6, pp. 91–156 of University of California Publications in Entomology. Price 75 cents.

Pages 91 to 113 are a very interesting review of what is known of the life history and habits of Strepsiptera. In the last ten years or so several life histories have been fairly well worked out. Enough has been done on the anatomy to learn that neither sex feeds as an adult, that the female in some species in the middle and later instars breaks down internally so that the eggs are mixed among fat cells in the general sack of abdomen and thorax. Later the last larval skin becomes a puparium with an opening above the neck area of the bag-like female. The male copulates with this opening in the puparium. The very active sperm pass along the back of the female underneath the puparium (the brood passage) and enter the female through an opening at the apex of the sac-like abdomen. The larvae when hatched crawl out through the brood passage the neck opening of which lies just outside the body wall of the host. Polyembrony has been described for Halictozenos by Noskiewicz and Poluszynski (1924). The active female of Eoxenos has been described by H. L. Parker and H. D. Smith (These Annals, 1933 and 1934). Bohart gives keys to males, females and first stage larvae which are active, triungulin-like creatures.

The volume is well written and a convenient summary of what is known of the very parasitic group.—C. H. K.

THE PARASITIC FLY, ZELIA VERTEBRATA SAY
(Diptera, Dexiidae)

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In an ecological study of *Passalus cornutus* Fabricius (Pearse, Patterson, Rankin, Wharton, 1936) the parasites and commensals were studied. The Dexiid fly, *Zelia vertebrata*, infested large larvae and pupae, the average number within a single Passalus was 0.1.

The parasitic larvae are first found about July 15. During this time the adult flies may be found in the tunnels made by the beetles in the decaying wood. The females larviposit in choria at points where maggots can find their way to the host (Townsend, 1936). The first stage larvae are elongated and vermiform, adapted for burrowing. At this stage they have a metapneustic tracheal system (Imms, 1937). *Zelia* has been reared from elaterid and scarabaeid grubs. In the control of wireworms *Zelia* and its allies might be utilized.

The parasitic larva breathes free air by means of an opening in the body-wall of the host, the opening through which it entered. It becomes enclosed in a sheath, which is cutaneous in origin, and is formed by an ingrowth of the integument from the margin of this perforation. The opening serves as a respiratory pore. This parasitic larva is maintained in the body-cavity of the host, with its posterior extremity containing the spiracles firmly supported in the aperture. The funnel-like sheath consists of the same layers as the integument, its lining is continuous with the external cuticle, forming a stout funnel growing around three or four of the most posterior segments of the parasite (fig. 5). The larva finally frees itself from the body-wall of the host but continues to live in the body-cavity of the host. Usually one fly larva is found in a beetle larva but as many as three have been found. The rugous Dexiid larvae differ from the smooth Tachinid larvae (Greene, 1925).

The anal stigmata of the maggots are in a shallow depression, the plates slightly raised but little separated. Each plate bears three nearly straight slits with an inner lower marginal button (fig. 4). The larvae reach a maximum size of about 16 to 17 mm. in length and 4 mm. in diameter. The small larvae with respiratory funnels measure 4 to 6 mm. in length and 1 to 1.5 mm. in diameter; the larger larvae with the respiratory funnels measure 12 to 13 mm. in length and 2.5 to 3 mm. in diameter.

The puparium is smooth without spine-like hairs, with a shallow depression containing the stigmal plates. The upper surface is nearly straight in profile. The anterior spiracle is a small projection on the side near the apex. The puparium measures about 13 to 14 mm. in length and 4 mm. in diameter. It is like that of Tachinidae except the spiracular plate always has three slits (fig. 7).

The time required for the development of the larvae observed in this study was not very accurate as the time of infection of the beetle larvae was not known but the mature fly larvae left the beetle larvae in about 15 days, which was the maximum time. The pupal stage was variable in length as the external factors were not controlled as closely as the conditions would be in the decaying log; the log gives a fairly stable environment. The adults appeared in 11 to 14 days.

The object of this paper is not to contribute anything to the classification of this fly, but to give some information on its development. These facts were found in working with certain organisms associated with beetles.

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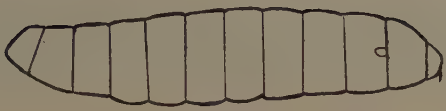
EXPLANATION OF PLATE I

Fig. 1. Larva, lateral view. 2. Cephalo-pharyngeal sclerites, ventral view. 3. Cephalo-pharyngeal sclerites, lateral view. 4. Posterior spiracular plates of larva. 5. Larva and respiratory funnel. 6. Puparium, lateral view. 7. Posterior spiracular plates of pupa. 8. Head of adult, lateral view. 9. Wing of adult.



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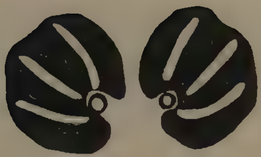

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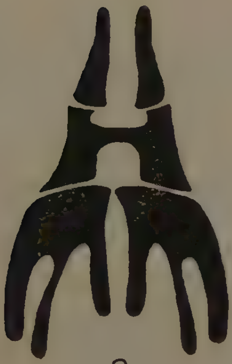

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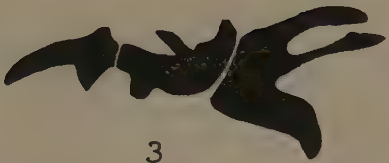

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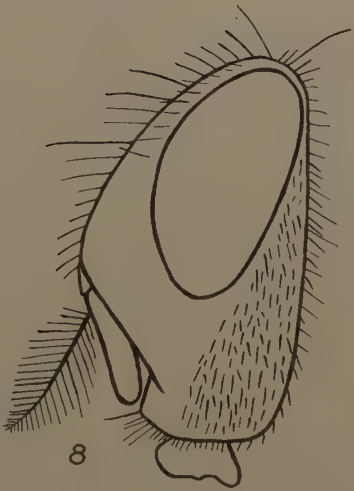

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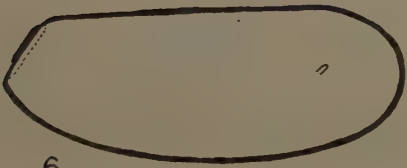

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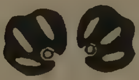

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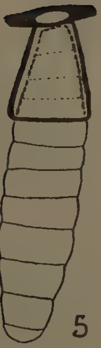

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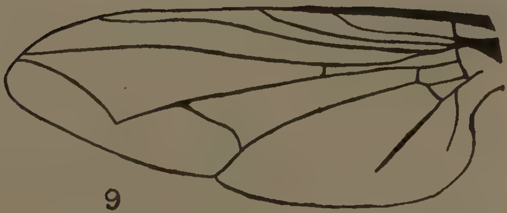

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DIMORPHISM IN THE FLYING WINGS OF A SPECIES OF WATER BEETLE, AGABUS BIFARIUS (KIRBY)

(Coleoptera: Dytiscidae)[1]

Hugh B. Leech[2]
Vernon, British Columbia

The ability to fly to new waters is a necessity for those species of water beetles (Hydradephaga and Palpicornia) inhabiting ephemeral ponds and streams. One is not surprised to find that flightless species are rare; Sherman (1913) has stated that the Nearctic dytiscid *Agabetes acuductus* (Harris) is without wings, but he may have intended to refer to *Agabus bifarius* (Kirby), since those *acuductus* which I have examined are all fully winged. According to Guignot (1933) the two species of the rare dytiscid genus *Siettitia* Abeille de Perrin, are "complètement aptères," and are known only from deep wells in the south of France. J. Balfour-Browne (1939) has described a new genus and species of hydrophilid from Lake Tanganyika, in which the wings are reduced to mere functionless slips.

Sharp (1882) reported *Agabus bifarius* to be flightless, and students have followed him in saying that the wings are always reduced in size. An examination of one hundred and fifty-six specimens of *bifarius*, from western Canada and the northeastern United States, shows that the wings may be either fully developed (fig. 2) or much narrowed and shortened (figs. 1 and 3).

HISTORICAL

In 1837 Kirby described a water beetle from latitude 54 degrees, near Hudson Bay, as *Colymbetes bifarius*, remarking upon and illustrating the curious acuducted elytral sculpture. Crotch (1873) included it with a question mark in his genus *Ilybiosoma*, and noted that it might represent a new genus, or go into *Eriglenus* Thomson. Sharp (1882) made it the sole representative of Group 23 of his treatment of the genus *Agabus*, and drew attention to the reduced wings. Semenov (1899) included it, with the genotype *Agabus kessleri* Hochhuth of Russia, in his genus *Apator*. The reduced-type wing of *bifarius* was illustrated by Arrow (1924). Zimmermann (1934) placed *A. kessleri* as a synonym of the earlier *bifarius*. For reasons stated in the preceding paper,[3] I consider the genus *Apator* Semenov to be a synonym of *Eriglenus* Thomson, the latter at present included in *Agabus* Leach, *s. lat.*

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[1] Contribution No. 2078, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Ontario.

[2] Acknowledgments: The following persons have generously loaned specimens from their personal collections, or from those in their care: Dr. P. J. Darlington, Jr., Cambridge, Mass.; Mr. W. J. Brown, Ottawa, Ont.; Dr. E. C. Van Dyke, Berkeley, Calif.; Mr. Ralph Hopping, Vernon, B. C.; and Mr. G. Stace Smith, of Creston, B. C.

THE WINGS

It is not within the scope of this paper to discuss the identity of the wing veins; in fact this cannot be done until someone has produced a basic study of the coleopterous wing. An investigation of the basal sclerites or pteralia (*sensu* Snodgrass) of *A. bifarius*, indicates that the vein designations used by Forbes (1922) are essentially correct.[4] There is one character by which a dytiscid wing may be recognized at a glance; near the median posterior border there is an oval pigmented spot, joined along its anterior margin to the postcubital (1st anal) vein (fig. 2.) Upon examination with a compound microscope, this pigmented oval is found to be closely set with short chitinous pegs; many workers have figured this spot when drawing dytiscid wings, but its true significance has only recently been discovered. In an interesting article on the stridulatory organs in certain families of beetles, Arrow has shown that when a

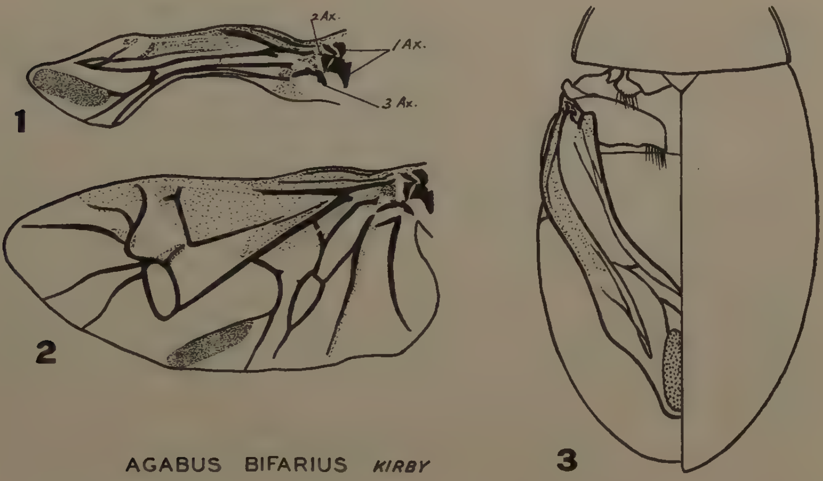

Fig. 1. Reduced-type of wing, *Agabus bifarius* (Kirby). Fig. 2. Fully developed wing, *Agabus bifarius*. Fig. 3. Outline of *A. bifarius*, left elytron removed, to show reduced-type of wing in position.

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[3] Leech, Hugh B., 1942. Key to the Nearctic Genera of Water Beetles of the Tribe Agabini, with Some Generic Synonymy. Ann. Ent. Soc. America, 35 (2): June issue, 1 plate.

[4] As an example of the present chaos in the naming of coleopterous wing veins, it is extremely interesting to compare the papers by Forbes (1922), Saalas (1936), and Goodliffe (1939).

dytiscid's wings are folded in their natural position, the pigmented spot of each occupies an exactly longitudinal position, and the two coincide with the junction of the elytra, a little before the apex (fig. 3). At exactly this place, each elytron shows on its lower surface a prominent strip which is not glossy like the remaining surface, but microscopically shagreened, as in the family Erotylidae; these two opposing surfaces constitute a stridulatory apparatus.[5] The stridulatory pigmented spot may vary somewhat in shape, depending upon the genus, but seems to be present in all Dytiscidae.[6]

The following tabulation is a summary of the wing conditions found in *Agabus bifarius*; since relatively few localities (about thirty in all) are involved, they are cited by their respective Provinces or States.

LOCALITY	NUMBER OF SPECIMENS WITH:			
	Normal Wings		Reduced Wings	
	Males	Females	Males	Females
British Columbia (various stations)	6	12	6	11
British Columbia (ephemeral pond near Vernon)	....	....	8	4
Alberta (chiefly Edmonton)	15	12	8	9
Saskatchewan	....	....	....	1
Manitoba	4	3	2	....
Ontario	....	....	....	1
Quebec (chiefly Natashquan)	2	4	6	6
New Hampshire	....	1	....	....
Massachusetts (chiefly Tyngsboro)	2	9	6	15
Illinois	....	1	....	1
Minnesota	....	....	....	1
Totals	29	42	36	49

During April and May, 1939, twelve specimens were collected in a pond, an overflow from Deep Lake near Vernon, B. C.; all had reduced wings. None was found in Deep Lake itself. This is especially interesting in view of the fact that the shallow, weedy flood pond in which they occurred had completely dried up before the end of July; by the first week in August the ground, previously under water, was criss-crossed with fissures half an inch deep. In mid-September a search was made for adults of *bifarius*; none was found, though two *Agabus strigulosus* (Crotch) and three *Haliplus* sp. were discovered under a log partially embedded in the soil. This is a common method of aestivation amongst the water beetles.

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[5] F. Balfour-Browne, 1940 (see review of his "British Water Beetles," Vol. I, Ann. Ent. Soc. Amer., 34 (4): 808, 1941), does not accept Arrow's interpretation, and suggests that the method of stridulation in most Dytiscidae is still unknown.

[6] Its strong development in the wirgs of the Amphizoidae, and its absence from those of the Omophronidae and Haliplidae, may be of some phylogenetic importance.

An examination of the wings of *bifarius*, and an experiment with the living beetles, makes it fairly certain that those with reduced wings are unable to fly. It must be presumed that these adults aestivate below the surface of the soil, or possibly in decaying water-soaked logs[7]; and though it seems hardly possible, their larvae must be able to mature and pupate before the ponds dry up in mid-summer. I have found *bifarius* only in ephemeral ponds, but they are known to occur in permanent waters; in fact the latter is probably their natural habitat. An analysis of the dates of capture of the short-winged specimens studied, shows that they, like the fully-winged examples, are found from May to September inclusive, in the west; and from March till September in the east.

FLIGHT

The following rather crude experiment was tried, to see whether or not the short-winged adults of *bifarius* are capable of flight. On May 2, 1939, four males and three females, all with reduced wings, were placed in water in a large straight-sided glass jar, inside a glass-fronted cage. A few rough sticks tied near the top, and arranged like the tepee poles of an Indian wigwam, were so placed that the tops protruded a little above the jar, but were not within an inch of the edge. A pair of *Agabus smithi* Brown and one *Haliplus* sp., all fully winged, were added; mutilated earthworms were provided as food.

By May 8 the water was becoming foul; all beetles were alive, but none had escaped from the jar, so most of the water was removed to force them to migrate. On May 9 the male *A. smithi* and the *Haliplus* had flown, and were clambering around on the floor of the large cage; the *Haliplus* was returned to the jar. The female *A. smithi* flew from the top of the sticks on the 11th, and the *Haliplus* was also out again that day. The *A. bifarius* were still alive and active.

Although the evidence that *bifarius* can not fly is chiefly negative, it seems to be satisfactory. Both the *Agabus smithi* escaped by flight, and the *Haliplus* got out twice, while the *A. bifarius*, though they often climbed up the sticks, did not leave the jar.

VARIATION IN FORM AND SCULPTURE

Males from the north-west are appreciably darker and more robust than are those from north-eastern Canada and the adjacent States.

Typically, the elytra have a ground sculpture of small, rounded meshes, of equal size. Superimposed upon this are the aciculations, narrow linear impressions, usually a little curved or sinuate; they are longitudinal discally and oblique laterally in the basal half of each elytron, transverse in the apical half. There is little variation in the males; in some the aciculations are less numerous on the disk, basally, while western and northern specimens tend to have the ground sculpture slightly coarser, and hence are more opaque.

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[7] Venables (1913) has given an interesting account of having found many *Agabus semipunctatus* (Kirby) and *A. antennatus* Leech (*A. clavatus* Leconte, nec *clavatus* Latreille) hibernating in a wet and rotten log. Mr. Venables tells me that this log was on the west shore of Deep Lake, only a few hundred yards from the above-mentioned locality for *A. bifarius*.

With British Columbia and Alberta specimens at hand, one can separate the sexes at a glance; in the males, the discal longitudinal aciculations are well separated, and of irregular lengths, while in the females they are numerous, elongate, and close together, so that the elytral surface is much duller. In *bifarius* from eastern Canada and the United States, however, the two sexes are similarly sculptured; though I have seen a female from Merivale, Ont., and one from Covey Hill, Que., which are like those from the west; a female from St. Paul, Minn., shows an intermediate condition.

As was mentioned in the preceding article, I have a pair of *bifarius* from Marion, Mass., collected by Bowditch, in which the aciculate elytral sculpture is entirely lacking in the male, and present only vaguely on the apical third in the female; both specimens have reduced wings.

None of the above-mentioned elytral variations is restricted to either type of wing.

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THE OENOCYTES OF TENEBRIO

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While studying the odoriferous glands of the adult *Tenebrio molitor* L. and those of *T. obscurus* Fab., interesting groups of cells were found (in both sexes) in close association with the fat bodies and tracheal system. From their structure and position they are undoubtedly oenocytes. The author feels that, because of their unusual size and number, they should be brought to the attention of other workers.

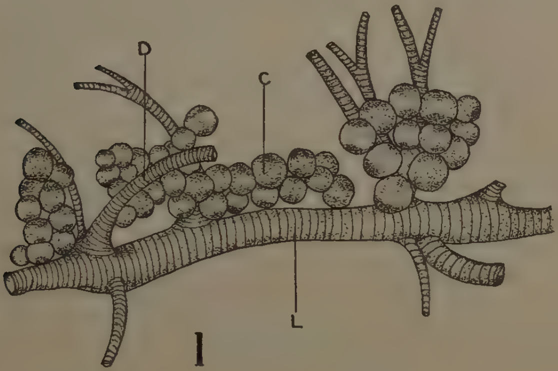
In the adult Tenebrio, the oenocytes are arranged in grape-like clusters along the whole length of the dorsal surface of the lateral longitudinal tracheal trunks of the abdomen and may also extend upwards along the dorsal tracheal trunks in the region of the spiracles (fig. 1). The only connection between the tracheae and the oenocytes is that of contact. They apparently do not run along the ventral tracheal surface. The clusters lie in among the fat bodies but can be easily recognized by their brown color.

A cluster may be composed of a variable number of individual cells which in turn may vary in size (fig. 1). These cells are generally round, but are flattened where they are in contact with another cell (fig. 2). They range in diameter from 96 mu to 170 mu, with an average of 131 mu. The size of this individual oenocyte is not unusual, for this gland cell is generally large in all insects. However, the clusters themselves may reach a length of 1,600 mu or more and when freed from the fat bodies and tracheae are easily discernible with the naked eye. The nuclei are very large and may be round or slightly elliptical. They generally occupy the center of the cell and appear to possess a honeycombed structure (fig. 2, N). (Vickery, 1915, also reported a similar structure in the nuclei of silkworm oenocytes.) Small clumps of brown granules, which impart the characteristic color to the cells, are found in the cytoplasm. These are generally more numerous in one or more regions of the cytoplasm so that in many glands the granules are concentrated at opposite ends of the cell (fig. 2, G). However, sometimes they are found around the nucleus and occasionally may take up all of the cytoplasm so that the nucleus is almost completely hidden. That part of the cytoplasm not containing the large brown granules is granular and colorless (fig. 2, C). Usually a few brown granules are distributed in the colorless region of the cytoplasm. These cells rupture easily on the application of pressure and liberate their granular contents.

Larvae also possess these glands and, as in the adult, they lie along the lateral tracheal trunks. Unlike the adult oenocytes, the larval cells are smaller and more compact. The brown granules are also smaller, fewer in number, and are generally more evenly distributed throughout the cell so that the cytoplasm has a more uniform appearance. For this reason they are also less conspicuous than the adult oenocytes where a concentration of pigment granules gives them a definite brown color. Apparently, in the adult, these granules migrate and congregate at definite regions of the cytoplasm. There is a decided increase in the size of the individual oenocyte with increase in age of the larva. They appear to reach their maximum size in the adult.

The structure and position of these glands fits in with the description of oenocytes in general. Snodgrass (1935) states that, "The oenocytes are large cells found in the body cavity of most insects, either arranged in groups or scattered individually among the tissues of the abdomen, where they are usually associated with the fat cells. . . . In Trichoptera and Lepidoptera the oenocytes are free from the body wall and occur in groups connected with tracheae in the neighborhood of the spiracles, the cells being held together by finely branching tracheal tubes. In Coleoptera they form loose clusters or bands of cells along the sides of the abdomen lying against the visceral organs. . . . The term 'oenocytes' refers to the usual pale amber color of the cells, but the latter are in some insects, brown, yellow, green, or red, and sometimes colorless." Oenocytes have been described in many insect species and the functions attributed to these glands have also been numerous (*see* Wigglesworth, 1939, pp. 241–245). It is impossible to state whether or not these cells have something to do with reproduction, the removal of waste products from the blood, or perform some other important function in Tenebrio, until a detailed histological study of them is made and this correlated with the various morphological changes which occur during metamorphosis.

The large number of these cells and the huge size of the clusters makes them excellent material for the demonstration of living oenocytes and also for micrurgical and other experimental studies. Since Tenebrio can be easily reared in the laboratory, abundant material is assured. The method used for demonstrating these glands is as follows: Etherize the beetle, remove elytra and wings (also legs so as not to interfere with pinning) and pin through the thorax in a paraffin dissecting dish. Flood the animal with normal saline solution. Slit open the mid-dorsal cuticula and pin the sides down with insect pins. Carefully remove the digestive and reproductive tracts and pick away the fatty tissue from the tracheal trunks. The brown oenocytes stand out clearly among the grayish fat bodies. In some cases the oenocytes which extend along the dorsal tracheal trunks closely adpressed to the tergum may be visible through the dorsal cuticula. For studying larval oenocytes, the incision is also made along the mid-dorsal line of the insect. For demonstration purposes, the oenocytes found



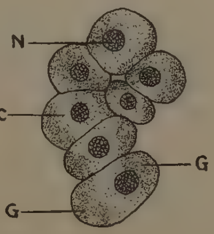


Fig. 1. Partly schematic drawing of a portion of a lateral tracheal trunk (adult) showing position and clusters of oenocytes. (Dissected in normal saline solution; unstained; fat bodies not included; Ocul. ×15, Obj. ×2.6; drawn with the aid of camera lucida; nuclei are not visible under binocular.)

C—Clusters of oenocytes. D—Dorsal tracheal trunk. L—Lateral tracheal trunk.

Fig. 2. Part of a cluster of oenocytes (adult) showing position of the granules and nuclei. (Dissected in normal saline; unstained; Ocul. ×7.5, Obj. ×10; drawn with the aid of camera lucida; cells under slight pressure of cover slip.)

C—Colorless cytoplasm. G—Brown granules. N—Nucleus.

in the adults are best because of their larger size, darker pigmentation, and the fact that adults have less fatty tissue.

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NOTES ON THE PREPARATION OF PAPERS FOR PUBLICATION IN THE JOURNAL OF HYGIENE AND PARASITOLOGY, by the late G. H. F. Nuttall, MD., Sc.D., Ph.D., LL.D., F.R.S. Pages 1–62. 1940. Card-board bound, 7 x 10 inches. Published by The University Press, Cambridge (England) and in the U. S. A., The Macmillan Co., 60 Fifth Ave., New York. Price, $1.15.

This volume on the preparation of scientific manuscripts is one of the most useful books that has come to our attention in recent years. Professor Nuttall was England's leading parasitologist and one of her ablest editors in the field of biological science. As editor of the two journals, "Parasitology" and "The Journal of Hygiene," he had broad interests in the proper presentation of scientific thought and through his editorial work learned just what instruction the scientist needed. We usually would not recommend such a volume for reading yet an enjoyable evening was spent in reviewing the rules, examples and reasons for particular usage set out by Editor Nuttall. It is a book that will be equally interesting to any writer who strives to improve his scientific exposition.

After a few generalities on such subjects as editorial acceptance of articles, responsibility of the author towards copyright rules, simultaneous publication in two journals and infractions of the goodwill relationship between editor, author and publisher, the work proceeds with Part II. The Preparation of Manuscripts. On this subject are seventy-two sections numbered in Clarendon (black type) for back reference. This part occupies forty-five pages and constitutes the main part of the volume. It regularly cites examples of good and bad usage, is elaborately crossreferenced and is remarkably clear and concise.

Part III. How Authors Should Send Manuscripts and Illustrations to the Editor, occupies four lines. Part IV. Proof-Reading, covers seven pages. Part V. Reprints, occupies three paragraphs, while Part VI. The History of a Paper After It Has Been Sent to the Editor, covers two pages and completes the text. The whole body of the text (Parts I–VI) totals eighty-seven "Notes," each with its black-face numeral. Many of the Notes are again elaborately subdivided into paragraphs numbered in Roman. The work has an index of nearly 800 items.

The elaborate but very clear organization of the book is a fascinating feature. It is obvious that the volume is a work of love by a master hand, a project that absorbed spare time and to the study of which the author must have returned again and again over a considerable period of time. It could not have been worked out in such brilliant detail by any system of forced composition. Professor Nuttall has followed his own repeated instructions on making a point clear "where there is any conceivable chance of confusion."

The author constantly drives at clearness, simplicity and brevity. While many pages are devoted to the correct use of various commonly used words and phrases always there runs through the whole that vital thread of a striving toward more precise speech. The student soon comes to realize that sound scientific thought is possible only with a simple, clear and brief style.

(For other than defense stamps) It would be difficult to suggest an investment of one dollar and fifteen cents that could bring more returns, than the investment in Doctor Nuttall's volume on better scientific English. The book is one of those so conscientiously written that it restores faith in men. It stimulates our neurohormone system until life again assumes a rosy tint.—C. H. K.

THE SEASONAL DISTRIBUTION OF SOME TABANIDAE (DIPT.) IN PANAMA

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A number of students of the Tabanidae have recorded their observations on the seasonal activity of these flies, but with a few exceptions their observations were made in temperate regions, and were for the most part based on limited or rather haphazard collections. In North America, Hine (1903, 1906) gives data for a few species of *Chrysops* and *Tabanus* found in Louisiana and Ohio, showing that some species, as *T. lasiophthalmus*, are on the wing early in the year (May and June), while others, as *T. sulcifrons*, do not appear until later (August and September). Mosier and Snyder (1919) studied the Tabanids of the Paradise Key area in southern Florida, and give tables showing dates of capture of the various species. *T. americanus* and *T. trijunctus* are extraordinarily abundant, the former from March to June, the latter for a very short period of two or three weeks in late March and early April. Other species, as *T. lineola*, *T. costalis* and *Chrysops flavida*, fly almost throughout the year. Webb and Wells (1924) working mainly with *T. punctifer* and *T. phaenops* found the former to be most abundant from about July 1 to August 20, while the latter did not reach maximum abundance so early, but was on the wing into September. Cameron (1926) working with the Tabanidae of the Canadian Prairie Provinces, where the summer season is comparatively short, found a few species (*T. lasiophthalmus* and *T. illota*) on the wing as early as late May, while *T. septentrionalis*, the latest flying species, was taken well into September. Most of the species had a rather short season of flight, generally from a month to six weeks. Stone (1930) gives a table showing the seasonal distribution of 37 species found in the vicinity of Ithaca, New York. Schwardt (1931), studying the biology of *T. lineola*, believed that the species, unlike most Nearctic Tabanidae, was double brooded, as although adults were on the wing from May 4 to October 9, there were two maxima with a period of scarcity in late July.

Philip (1931), dealing with the Minnesota species, gives charts showing the seasonal distribution of the various species. Here again some species, such as *Chrysops moechus*, *C. indus*, *T. metabolus* and *T. lasiophthalmus* are early species, others, like *T. actaeon* and *C. sackeni*, are more abundant in the latter part of the summer, while *C. excitans*, *C. montanus*, *T. atratus* and a few others have a long flight season. The present author (Fairchild, 1937) in a list of the Florida species, has given dates of earliest and latest capture for a number of species occurring about Monticello in the northern part of the state. A few species were on the wing as early as late March, and several occurred at least to the middle of September, when collecting ceased. *Chrysops divisa* and *C. brimleyi* were early spring forms, the former not being taken after April 30. *T. annulatus* had a short season from July 10 to August 18, and *T. hinei* was taken only from August 30 to September 21. *C. flavida* and *vittata*, *T. turbidus* and *mularis*, on the other hand, have long flight seasons, from April or May into September.

In Greece, Shannon and Hadjinikolaou (1936) give some notes on the seasonal distribution of some Macedonian species. Thus *Tabanus quatuornatus* appears to have a short season in spring (April-June), while *T. autumnalis* extends its season of flight from April to October. In the genus Haematopota, of seven species all but *H. fraseri* have very short flight seasons, that species having been taken from May to October. Efflatoun (1930) in discussing the Egyptian species finds an essentially similar situation. *Tabanus alexandrinus* having a short early spring season (March-April), while *T. agrestis* and *T. taeniola* are on the wing from April to October.

In the tropics, Mitzmain (1913) in an intensive study of *Tabanus striatus* in the Philippines, states that the fly first appears on the wing about the middle of August, but does not reach great numbers until October. From then until March it is very abundant, which indicates that the species is predominantly a dry season form, as the Manila area has a winter dry season. Neave (1915) in his classic study of the Tabanidae of Southern Nyasaland, concluded that all the species were single brooded. Most of the species on which he gives information fly only during the rainy season, which is said to occur from November to March. *Dorcaloemus fodiens* and the two species of *Silvius* recorded have very short seasons, not over a month, the first in April, the latter in October and December. *Chrysops longicornis*, *wellmani* and *magnifica* all fly nearly throughout the rains. *Haematopota mactans* also flies during the whole rainy season, while the other three species of the genus all have quite short flight seasons. Of the species of *Tabanus*, only *T. taeniola* has a long season, from October to May, the other species mostly being limited to a couple of months. The same author also gives notes on a few African species in earlier papers (Neave, 1911, 1912).

Without doubt a thorough search of the literature would disclose considerably more information on seasonal distribution, but the work reviewed above all tends to show that the majority of Tabanids, both in temperate and tropical regions, are single brooded, and that each species has a rather definite flight season which may be very short. The exceptions seem to be species which either complete more than one life cycle during the year, or in which the length of the cycle is so irregular due to great variation in the length of the larval stage, that adults are emerging throughout the year.

The present investigation was undertaken to see if the above generalization was applicable to the Tabanidae found in Panama. For this purpose the services of a relatively reliable native collector were secured, and beginning on March 9, 1940, collections were made approximately every two weeks until March 5, 1941. The collector was paid a small sum for each fly brought in, except that if more than 700 or 800 were taken the price per fly was reduced. Collections were made using horses for bait, and occasionally cattle also. Each collection represents the result of approximately two days collecting, but in some cases this was exceeded. Collections were made about the home of the collector, a small settlement of a few families at Moja Pollo, on the banks of a small tributary of the Chagres river of the same name. The locality is between Madden Dam and Gamboa in the Chagres valley, and lies on the Atlantic side of the Continental divide. The area is one of mostly second growth scrub forest with but a little of the original forest remaining. About the mouth of the Moja Pollo there is a large area of swamp and much floating vegetation. The climate, as recorded at the weather station at Madden Dam, a few miles upriver, is fairly uniform as regards temperature. The mean annual temperature is about 77° F., the absolute maximum being 98° and minimum 59°. On the whole, the lowest temperatures are reached in January and February, the highest in April and May, the greatest daily range being during the dry season. The rainfall by months for the period during which collections were made, and the ten year monthly averages are shown at the bottom of the accompanying figure. As can readily be seen, the year is rather sharply divided into a wet and a dry season, the rains generally beginning in May and lasting through December.

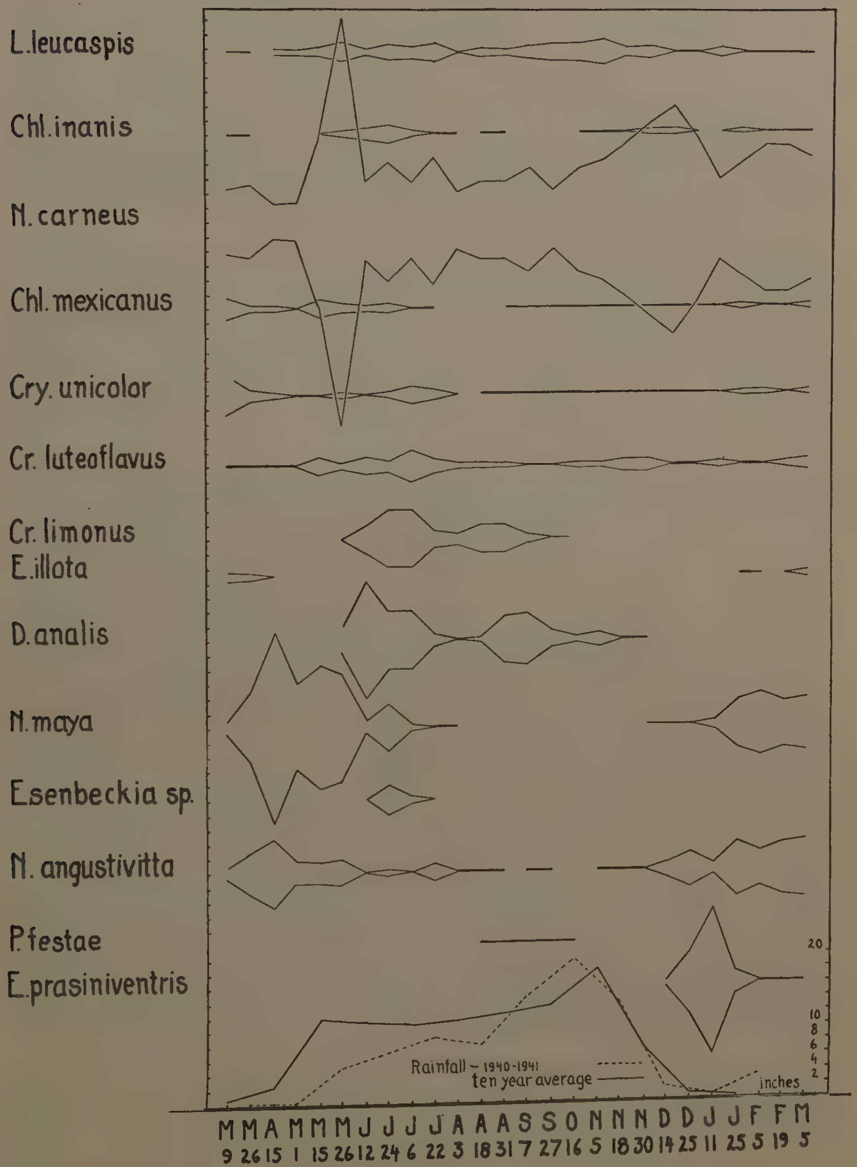
During the year 26 collections were made, and a total of 11,997 Tabanids taken, representing 35 species. Nearly half (49.1%) of all flies taken belonged to one species, *Tabanus* (*Neotabanus*) *lineola* var. *carneus* Bell., while the next most abundant species, *T.* (*Neotabanus*) *maya* Beq., accounted for 12.5% of the total. Eleven other species together accounted for but 35% of the catch, while the remaining 21 species made up the balance of 3%. A list of the species taken, with the numbers of each is given below:

Esenbeckia prasiniventris Macq	411
“ *illota* Will. var	55
“ sp	67
“ *translucens* Macq	1
Pityocera festae Gig.-Tos	14
Chrysops variegata de Geer	32
“ *malaena* Hine	1
“ *calogastra* Schin	1
Dichelacera analis Hine	766
“ *marginata* Macq	1
Psalidia fulminea Hine	2
Chlorotabanus mexicanus Linn	221
“ *inanis* Fab	136
Cryptotylus limonus Town	425
“ *luteoflavus* Bell	351
“ *unicolor* Wied	278
Diachlorus curvipes Fab	1
Lepiselaga crassipes Fab	93
Selasoma tibiale Fab	2
Leucotabanus leucaspis Wied	412
“ *canithorax* Fchld	6
“ *flavinotum* Krob	3
Stenotabanus plenus Hine	2
Tabanus (*Phaeotabanus*) *medius* Krob.	26
“ (*Bellardia*) *pseudoculus* Fchld	105
“ (*Bellardia*) *albocirculus* Hine	30
“ (*Hybomitra*) *quadripunctatus* Fab	9
“ (*Neotabanus*) *lineola* var. *carneus* Bell	5661
“ (*Neotabanus*) *lineola* var. *stenocephalus* Hine	190
“ (*Neotabanus*) *maya* Beq	1441
“ (*Neotabanus*) *angustivitta* Krob	859
“ (*Neotabanus*) *amplifrons* Krob	39
“ (*Neotabanus*) *fumatipennis* Krob	5
“ (*Tabanus*) *ferrifer* Wlk	49
“ (*Tabanus*) *importunus* Wied	125

In the accompanying figure an attempt has been made to show the seasonal abundance of a number of the more common or characteristic species. The vertical distance between horizontal lines indicates the number of specimens taken at each of the 26 collecting periods, each unit of the scale along the left margin indicating 25 specimens. A single line indicates 5 specimens or less. The month and first day of the collecting period are shown at the lower margin.

Seasonal Distribution of Tabanidae
G. B. Fairchild

PLATE I



It will be readily seen that the species fall roughly into three groups:

(a) Those without a definite flight season (*L. leucaspis* to *Cr. luteoflavus*).

(b) Those with a flight season corresponding in the main to either the wet (*Cr. limonus*, *D. analis*) or the dry (*N. maya*, *N. angustivitta*) seasons.

(c) Those with a very short and definite season which may be either in the wet or the dry season (*E. illota*, *E.* sp., *E. prasiniventris* and *P. festae*).

Of those species not shown in the graph, many are represented by too small a number of specimens for a statement to be made. *Lepiselaga crassipes*, *N. lineola* var. *stenocephalus*, *N. amplifrons* and *Chrysops variegata* appear to fall in group "a." The two species of *Bellardia* and *Phaeotabanus medius* seem to be strictly wet season forms, while *T. ferrifer* and *T. importunus* have a period of maximum abundance in April and May, with another appearance in small numbers in September to December. These last two species are the only ones which show indications of two distinct broods, but whether due to two life cycles a year, or two separate broods with an annual cycle must await a careful study of the life history.

It is interesting to note that *T. lineola* and related forms are the dominant group numerically, and that *lineola* itself is almost uniformly abundant throughout the year. In North America also, it is a long season form, while *T. taeniola*, an apparently related African species, seems to have similar habits. Although the *Pangoniinae* are rather poorly represented in Panama, all, with the exception of the species of *Chrysops*, seem to have very short flight seasons. While collecting in Brazil, the present author got a similar impression in regard to the species of *Esenbeckia* and *Fidena*, though no uniform data were secured. Neave (1915) seems also to have found the *Pangoniinae* which he collected (*Dorcaloemus fodiens* and two species of *Silvius*) to be very short season species.

It was unfortunately not possible to secure data on the time of day at which the various species were most active, but the collector reported that very few Tabanids were taken after 8 A. M. or before 4 P. M. From personal observation, it is estimated that fully 60% of the species are crepuscular, a situation in marked contrast to that found in North America. Some, like the species of *Chlorotabanus* and *Esenbeckia illota*, are practically nocturnal, while *Esenbeckia prasiniventris*, *T. ferrifer* and the species of *Neotabanus* are on the wing during the whole day, though perhaps less active during the hours from 10 A. M. to 3 P. M.

SUMMARY

The author reports a year's collecting of *Tabanidae* at two week intervals from a single station in Panama. The nearly 12,000 specimens taken represent 35 species of which a list is given. The seasonal distribution of 14 species is shown in graphic form, and the fact that the species may be grouped as to duration and time of flight period is noted. A brief review of literature is given, and some comparisons made with results obtained in other localities. The suggestion that types of seasonal distribution to a certain extent follow taxonomic groupings is put forward.

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LEUROLOPHUS, A NEW GENUS OF THE FAMILY PSYLLIDAE (HOMOPTERA)

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While undertaking a revision of the North American Psyllidae, which has been completed for the subfamilies *Triozinae* and *Psyllinae*, the author has encountered several new members of the family. One of the most distinctive of these novel forms is here described.

Leurolophus new genus

Head and prothorax deflexed. Vertex flat, margins straight. Frons large, median ocellus borne at apex beneath margin of vertex. Genae very slightly swollen. Eyes straight laterally, not hemispherical. Thorax flat. Pronotum very long and broad, almost equalling width of head. Propleurites unequal. Mesonotum small. Mesopleurites very strongly developed. Forewings rhomboidal, thickened, opaque, anal area very strongly developed, cubitus and media with common petiole, pterostigma lacking. Hind wings well developed, membranous. Legs short, stout. Distal tarsal segment elongate and incurved, proximal segment somewhat flattened on inner side and incurved, notched apically. Abdomen small.

Genotype: Leurolophus vittatus n. sp.

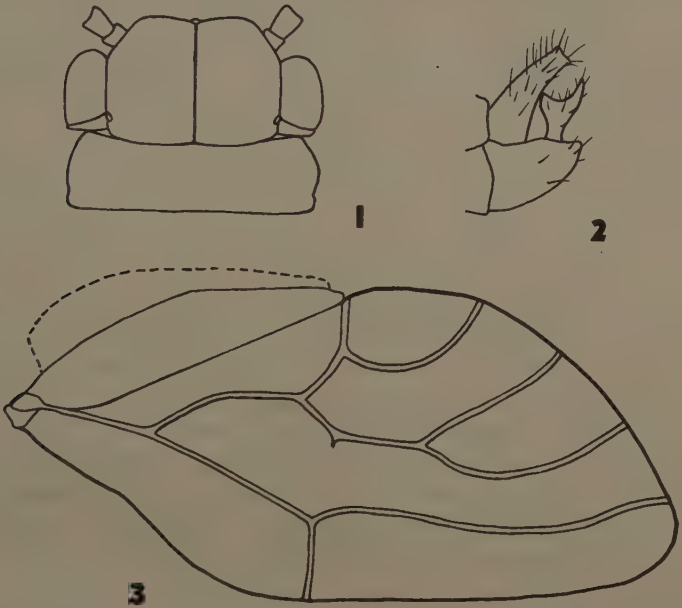
This genus resembles *Rhinocola* Förster and like the latter shows affinities with both *Livia* and *Aphalara*. It may be distinguished from *Rhinocola* by the thorax, especially the size and shape of the pronotum, the shape and venation of the forewings and by the peculiar tarsi.

Leurolophus vittatus n. sp.

Length to tip of folded wings 1.5 mm.

Color.—General body color dirty white with scattered small brown spots. A broad, somewhat irregular, reddish-brown vitta extending from anterior margin of vertex onto abdomen. Venter of head and thorax brown, abdomen light. Forewings white with a broad brownish band along apical margin, scattered brown spots throughout, most numerous along costal margin.

Structure.—Head and thorax coarsely punctate. Head and prothorax somewhat deflexed. Vertex flat, three-fourths as long as wide, median suture prominent, posterior margin straight, lateral margins straight along eyes then narrowed to anterior margin, latter very slightly emarginate. Lateral ocelli at posterior margin of eyes. Frons large, prominent, entirely visible in ventral view, extending to margin of vertex, median ocellus borne at apex. Genae scarcely swollen. Eyes nearly straight-margined laterally, curved anteriorly, one-half as long as vertex, not at all set into vertex. Pronotum flat, one-half as long as vertex, almost as wide as head including eyes. Propleurites very unequal dorsally, proepimeron produced dorso-caudad much beyond proepisternum. Mesonotum flat. Mesopleurites very strongly developed and knobbed. Meso and metascutellum strongly swollen dorsally. Forewings small, opaque, coarsely punctate, one-half as wide as long, rhomboidal; veins raised, prominent, basal vein (R+M+Cu) short, M and Cu branching opposite furcation of R, R_1 extending straight to costa, R_s curved apically, marginal cells of moderate size, anal vein and anal area very strongly developed. Legs short, stout, mesofemora very much enlarged. Tarsal segments incurved, distal segment elongate, proximal strongly notched on inner margin. Abdomen small.



Leurolophus vittatus, n. sp. Fig. 1. Dorsal aspect of head and pronotum. Fig. 2. Lateral aspect of male genitalia. Fig. 3. Forewing.

Genitalia.—Male proctiger narrow, somewhat tapering and curved caudad apically. Forceps about one-half as long as proctiger; in lateral view bearing a large anterior lobe, lobe and axial portion black tipped, sharp; in caudal view slender, nearly straight to black subacute apices. Female genital segment shorter than rest of abdomen; dorsal valve longer than ventral, stout, black tipped, apex very slender and acute; ventral valve stout, strongly turned dorsad near apex, truncate, emarginate apically.

Holotype, male, *allotype*, female, Tumicacari Mountains, Arizona, R. H. Beamer, July 22, 1938.

Types in Snow Collection, University of Kansas.

TEMPERATURE AS A FACTOR INDUCING THE HIBERNATION OF POLISTES ANNULARIS

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The queens of *Polistes annularis* in the Missouri valley spend the winter gregariously in crevices in rocky bluffs; in the spring they start new colonies, singly or co-operatively, in the trees, often very near to their home site of the previous season. Little is known of the beginnings of hibernation or of the influences which force them into it.[1] The following observations and experiments may help to bridge this gap.

It has been noted that at the end of the summer season, *P. annularis* do not go immediately into hibernation, but congregate temporarily in clusters some distance from the nest. The same behavior on a smaller scale, with variations, has been observed in *P. pallipes*.

The incidents which supplied the data occurred in two nests in my yard. These had been brought in from Pacific, Mo., in midsummer (1939) and artificially fastened to a door-frame of the barn. The adults which were on the nest at the time when it was taken had been left behind at Pacific, but both nests soon again became populated as the pupae in the cells became adult. These orphan wasps cared for the immature brood, brought many of the larvae to maturity, and at the close of the season (at the end of August) the number of wasps on both nests totaled more than two hundred.

On August 30, both nests were covered with wasps, but on September 2, when I next examined them, they were entirely empty. Searching about the barn, I soon found them assembled in a mass, piled three or four deep, on a porcelain insulating knob under the second story window of the same building twenty feet away, with an overflow, also huddled together, on the wall a few inches from the main body.

The weather[2] that day was warm, but for nine previous nights the minimum temperatures had varied from 60° F. to 71°. Each of the three following nights found them in the same place, their numbers intact, but during the warm part of each day most of them flew away in the warm sunshine. Those three days had a minimum temperature of 71°, 76° and 73° respectively. On the morning of September 6, the number in the aggregation was reduced to less than one-half; the missing wasps had congregated in a protected place just inside the window and not far from the first mass. During the previous night there had been a drop in temperature to 62° and most of the wasps had responded by seeking more protected quarters.

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[1] See my articles, The Behavior of Hibernating *Polistes* Wasps. Ann. Ent. Soc. Amer. 23: 461–466; 1930; 24: 515–518, 1931; Bull. Brook. Ent. Soc. 33: 228–229, 1938.

[2] All temperature records are from the official U. S. Weather Bureau reports at St. Louis. At Kirkwood, they are usually about 2 degrees lower.

The next three days, September 7 to 9, were the hottest in six weeks, the temperature going to 98° and 100°. On the night of September 7, I found that more than half had left the two aggregations and returned to the nests which they had deserted the week before. Why, I wonder, did some "decide" to go back and others "decide" to stay? There were no "old-timers" to influence the behavior of these orphan wasps, because all the queens that had experienced hibernation the year before had been left behind at Pacific. This of course would indicate that these maneuvers were not learned or imitative, but strictly instinctive; but also, since wasps often behave in various ways under new and perplexing conditions it is evident that this instinct is not ironclad but subject to "individual decision" or change under new conditions.

However, during the next ten days (with daytime temperatures high but minimums as low as 61°), the wasps on knob, wall and nests gradually disappeared and by September 17, 75% of them were gone. Cooler weather followed, so that only a dozen remained on one nest on September 21, and these gradually disappeared by October 2. Apparently all had now retired into hibernation.

During the winter, or whenever the temperature is as low as 43°, the wasps are in a condition of torpor,[3] but on warm, bright days in winter they come out and fly about in the sunshine. Even in their deep winter sleep they respond quickly to the invitation of the warmth and sunshine, for only a few hours of warmth are needed to waken them to activity. This was amply seen on January 2, 1939, when we saw hundreds of *P. annularis* flying in the sunshine about the dome of the State Capitol at Jefferson City, Mo. To be sure, the temperature was 62° then (at 2 o'clock), but less than twelve hours before it had been down to 37° F. Likewise on March 19, hundreds of wasps were flying about the bluffs of the sand caves at Pacific, Mo., in the afternoon, in a temperature of 72°, despite the fact that the night before it had been down to 29°.

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[3] Bull. Brook. Ent. Soc. 33: 228. 1938.

EXPERIMENTS

It was from the above group of wasps at Pacific that 30 were collected and brought into the laboratory to test experimentally their reactions to temperature changes. Although they had been flying in the afternoon, they formed into a ball-like aggregation when the evening chill overtook us on the way home. They were placed in a rectangular glass tank, 32 x 16 x 12 inches. The room was unheated, and next day all of the wasps were still in a torpid condition—in a loosely-knit mass. They remained so for several days.

By means of a small electric heater in the tank, the temperature was raised. When it was a little above 60°, the wasps withdrew from the mass and walked about the cage, and at 76° they were all flying briskly and eating lustily of fruit juice.

Then I placed some empty cardboard boxes in the tank and removed the heater. Next day, I found them all in a ball-like mass again in one of the boxes. For the next two days the room temperature was between 48° and 50°, and none of the wasps left the box. Then the temperature of the tank was again gradually raised with the heater, and when it reached 60°, four of the wasps came out of the box. In another half-hour, at 64°, half of them were out, and in another half-hour with the temperature at 70°, all were flying about, some of them eating heavily of the fruit juice which I offered.

After two hours of this performance, I removed the heater and placed blocks of ice in the tank, thereby reducing the temperature to 60° in 15 minutes. Immediately four wasps crawled back into the box, and within 15 minutes 5 more entered it. Unfortunately, I had to leave at that time, but when I returned three hours later the thermometer registered 54° and 28 of the 30 wasps were inside the box, in a loose cluster but not yet in a torpid condition.

Additional experiments later in the week showed that when the temperature dropped to 50° the wasps were always under cover, and when it rose to 60° a few of them would crawl out, but at 66°, all would be out flying about. It was interesting to find that around 55° they would always be under the lid but not close together, but at 50°, they were always massed. Even at 48°, they were not in a total torpor, but would move about slowly when prodded with a pencil. This hooks up nicely with what we saw in nature when at 62° *P. annularis* were flying actively at Jefferson City.

In conclusion, one may say that *P. annularis* respond quickly to temperature changes in their hibernating habits. At the end of summer, it does not require a prolonged spell of cold to induce them to begin preparations for hibernation, and likewise, it requires only a short duration of warmth in winter to call them forth from their hibernacle to temporary activity in the sunshine.

PALAEMNEMA LORENA AND P. MELANOCAUDA, NEW SPECIES OF DRAGONFLIES FROM NORTHWESTERN ECUADOR

(Platystictidae: Odonata)

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A violaceous brown species with white across face, prothorax wholly brown, a thread of pale color along first lateral suture; lower side and ventral areas of thorax pale; end of abdomen black. Described from one male and two females collected by David B. Laddey at La Lorena, Sta. Domingo, Prov. Pichincha, Ecuador, February 21–28, 1941. Types in my collection. La Lorena is in wet northwest Ecuador, elevation 550 meters. See these Annals 34 (2): 490, 1941. The name refers to the type locality. The three specimens while not shrunken and the wings not glassy do appear of light weight and to be semiteneral. The general dark color of pattern might be black at full maturity.

Palaemnema lorena new species

(Figs. 1–10)

Abdomen, male, including appendages, 36 mm.; female, 35 mm.; hind wing, male, 26 mm.; female, 27 mm.

Holotype Male—Labium with ligula dark brown, as are the outer halves of the palpi; maxillae pale except spines of laciniae; under surface of head black, slightly paler next foramen. Dorsal area of head, frons, post clypeus antennae and genae dark brown, almost black, except a minute pale area of half the area of an ocellus ectad to each of the paired ocelli.

Pleurostomae yellow; basal two-thirds of mandibles, ante-clypeus, and upper two-thirds of labrum glassy bluish white. Lower third of labrum and points of mandibles black (fig. 4; in fig. 4 the two plate triangles on postchypeus and lower edge of frons are highlights).

Prothorax rich dark brown on all surfaces (fig. 9).

Meso-metathorax (fig. 5) dark brown with a bronzy violaceous lustre, except middorsal keel, black, and the metepimera, lower half of metinfraepisterna and ventral surfaces pale (creamy yellow?); and a narrow pale (bluish?) stripe along metapleural (second lateral) suture which widens at its lower and on the little sclerite behind the mesocoxa. All coxae and legs pale yellowish with outer (dorsal) surfaces of femora pale brown and apices of femora darker. Wings with dark brown veins and stigmas; membrane very delicately yellowish brown, slightly darker between costa and first media and on wing tip beyond stigma.

Abdomen violaceous dark brown, gradually shading into a near black on segs. 9 and 10; seg. 1 with a pale basal dorsal cross bandd an lower half of side pale; seg. 2 with a less distinct pale basal ring; segs. 3–7 with distinct pale basal rings; seg. 8 with a vaguely suggested pale basal ring. Superior appendages pure medium brown; inferiors black (figs. 1–3).

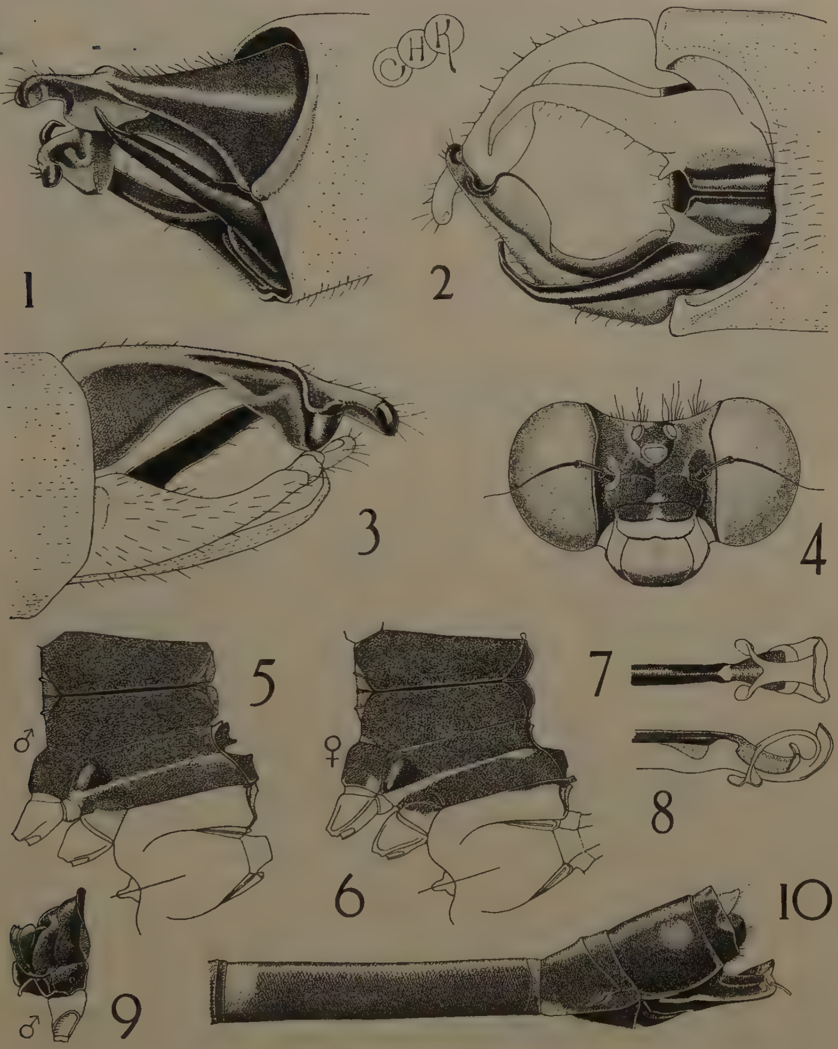
Structural Notes—On the occiput (fig. 4) are four tufts of long hairs. Prothorax and mesostigmal laminae are simple. Fourteen flat spines in the fore tibial comb and two flattened spines on base of fore femur. Apex of hind femur reaching middle of abd. seg. 2. Wings with 15 and 17 postnodals in fore pair, in hind wing, 15 and 15. M_2 arising under postnodal 6 in fore wings, under 5 in hind wings. In fore wings 15 and 13 Cu_2 cells; in hind wings 17 and 18; 2 post-quadrangular cells. Apex of wings reaching to distal half of abd. seg. 6. Penis (figs. 7 and 8) with unnotched and simple oval apical lobes. Appendages (figs. 1–3) with inferiors that have a well developed inner basal point (fig. 2) and attenuate apices preceded by two broad angulations. The superiors have no trace of a spur or lobe along upper rim, but have the broad apex with a deep right-angled notch leaving a narrow terminal round tipped lobe and, hanging below its base, a large flattened lobe on the inner surface of which is a U-shaped ridge (figs. 1 and 3). The appendages are distinctly hairy as are the under surfaces of abd. segs. 8–10 and the crest of the occiput with its four tufts. A low tuft occurs on the ventral surface of abd. seg. 2 in front of the fossa. Otherwise the body is very bare of hairs.

Female Allotype—Coloration of the female identical with that for the male. Abdominal segment 9 with what may be a pair of very obscure bluish spots on its apical half (fig. 10); ovipositor black with brown apex and pale styli. The female cerci (homologues of male superior appendages) are distinctly pale while the paraprocts (homologues of male inferiors) are black. Hairyness as in the male even to the four occipital tufts and the hairyness of the cerci and paraprocts, but ventral parts of abd. seg. 9 (ovipositor) bare, also the tuft on anterior ventral surface of abd. seg. 2 is lacking. Cerci broadly conical, from side view, but flattened on ental surface, four-fifths as long as seg. 10. Ovipositor with its apex under apices of cerci.

Wings reaching apex of segment 6. With 18 and 18 postnodals in fore wings and 16 and 17 in hind wings. M_2 arising below postnodal 7 in fore wings and below 5 in hind wings. Cu_2 cells are 14 and 15 in fore wings, 18 in hind wings. Two post-quadrangular cells.

Female paratype similar but of distinctly blacker shade of brown.

Relationships.—In Calvert's key (1931) the male runs out to *mutans* or to *reventazoni*. Both have lateral blue thoracic stripes several times as wide as that in *lorena*. Except for a distinct triangular point on the dorsal edge of the superior appendage in *mutans* male, *lorena* has appendages much like those of *mutans*. From *reventazoni*, *lorena* differs in its slender acutely pointed inferiors. In *reventazoni* the inferiors are twice



Palaemnema lorena n. sp.

Figs. 1–5 and 7–9, holotype male. 1. Male appendages from below and behind. 2. From below. 3. From above and slightly from right side. 4. Face. 5. Color, meso-metathorax. 7–8. Penis. 9. Prothorax.

Figs. 6 and 10, allotype female. 6. Color, meso-metathorax. 10. Abdominal segments 7–10.

as broad and have an apex minutely capitate. In *reventazoni* the superiors have a small spur midway on the dorso-ental edge.

The distribution suggests fairly close relationship of the three sbecies *inter* se. *Reventazoni* occurs in the ~~Pacific~~ /Atlanti drainage of Costa Rica, *mutans* in the Maracaibo drainage (Caribbean but extreme western Venezuela), while *lorena* is in the Pacific drainage of Ecuador. All are dark species suggesting wet areas. Is it possible that they represent three forms in a north and south distribution in wet Pacific coast areas of one stock in the genus Palaemnema?

On reviewing Calvert's (1931) figures, keys and descriptions we run into the same predicament in attempting to split the genus into subgroups as one meets in the same attempt on *Enallagma*. Excellent runs of related species occur then, just enough species with characters, a mixture of those of two groups, appear to invalidate sharp delimination of groups.

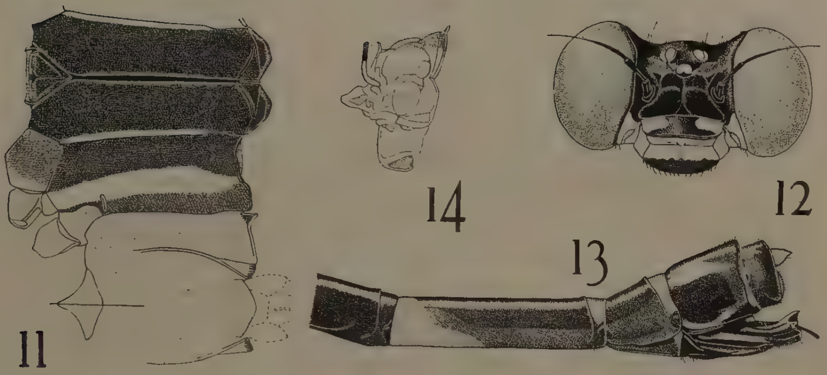
Palaemnema melanocauda n. sp.

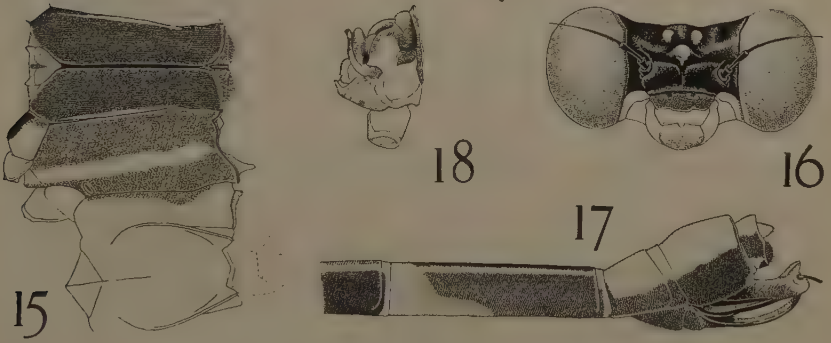
(Figs. 11–14)

This is a dark species with thorax brownish black on its dorsum and upper side; narrow antehumeral and broad metepimeral stripes blue; lower side and venter yellow; two blue oval spots on seg. 9 of the black-tipped abdomen. In Calvert's (1931) key it runs directly to the group containing *croceicauda* and *melanota*. The unique female holotype is in the author's collection. It was collected by David B. Laddey, January 4, 1941, at Santa Domingo de Los Colorados, Prov. de Pichincha, Ecuador, elevation 500 meters, which area in the humid northwest corner of Ecuador drains into the Pacific. Male unknown.

Female Holotype—Length of hind wing, 22 mm.; of abdomen, 30 mm.; postnodals 14–14 and 13–14; nodal sector arising at 6, f. wg., at 5, h. wg.

Labium pale yellowish with mentum and apices of lateral lobes infuscated. Lower half of labrum black, its upper half blue as are the genae up to the level of lower edge of frons. Fore pronotal lobe rounded. Vertical surface of clypeus, bases of mandibles and pleurostomae yellow with some dusky on bases of mandibles. Postclypeus violaceous black with a large yellow spot on each outer edge which contacts the frons above but not the anteclypeus below, its inner end rounded. Thus the black area is a broad T, its base on the edge of the frons. Upper half of each gena and frons and vertex black except a small semicircular yellow spot at outer edge of each of the paired occeli. Rear of head black. Antennae black (fig. 12).





Palaemnema melanocauda n. sp.

Female holotype. Fig. 11. Color pattern of meso-metathorax. 12. Face. 13. Abdominal segments 7–10. 14. Color of prothorax.

Palaemnema croceicauda Calvert

Female paratype in Williamson Collection, taken February 17, 1917, at Cristalina, Colombia, by J. H. and E. B. Williamson. Fig. 15. Color pattern of meso-metathorax. 16. Face. 17. Abdominal segments 7–10. 18. Color of prothorax.

Prothorax (fig. 14) pale on sides, darker above. Posterior lobe with middle two-fourths medium brown, outer ends pale brown. Anterior lobe brownish yellow, the triangular depression back of anterior lobe pale (bluish with application of "household ammonia" water), its sides and apex fitted between two dorsal brown triangles based on the base of posterior lobe. Sides below the three triangles pale (bluish in upper half with ammonia), yellowish below. Fore coxae yellow.

Meso-metathorax (fig. 11) with middorsal keel black, the mesepisterna brownish black as are the antealar sinus and mesostigmal lamina, except a narrow blue stripe of uniform width lying along each humeral suture from the mesinfraepisternum four-fifths of the distance to the alar carina. Mesinfraepisternum (badly injured by decay) probably pale brownish, darker above (no bluish with ammonia). Mesepimeron same brownish black as dorsum. Metepisternum with upper half occupied by a pale blue stripe, its posterior fourth tapering to an acute point at the alar carina, the lower half of the metepisternum dark brown, a shade paler than that of dorsum. Metinfraepisternum pale (yellow?) as are the metepimerum including the ventral posterior surface of thorax. Coxae pale yellow. The three sternites (between pairs of coxae) jet black. Legs: trochanters yellow, femora dusky yellow with brown stripe on dorsal (exterior) surface, apices ringed narrowly with brownish black; tibiae pale yellow; tarsi orange; spines black. Wings: hyaline; veins black, stigmas black (brown-black under scope).

Abdomen: Seg. 1 pale yellowish, narrowly ringed with black at apex, except the following intersegmental membrane pale brown; seg. 2 posterior third dark brown including its following membrane (apical ring) shading cephalad into the anterior pale area, also pale sides shading into brown along middorsal line; segs. 3–6 brownish black, except basal tenth of length a yellow ring. Seg. 7 (fig. 13) similar but the pale basal ring widening below and extending a ventral point caudad thus covering anterior third of lower side. In seg. 7 (and 8–10) the dark of dorsal side is paler than on segs. 2–6, is brownish with a violaceous sheen, its lateral edges are sharply delimited at mid level of side below (in 7) while the dark of the lower side is paler brown. The apical ring is pale on upper half (yellow in preservation). Seg. 8 as in 7, but no trace of pale basal area. Seg. 9 as in 8, but its sides, including lower edges, black from base to three-fourths the length, the apical fourth dark brown succeeded by a line of black about apex of segment. On the dorsum the violaceous dark brown area is a narrow triangle in shape, broader behind. On the upper side between the dorsal violaceous triangle and the black of the side is a narrow oval of blue (with ammonia), its base at base of segment and two-thirds as long as segment. Apical membrane pale. Seg. 10 with a similar violaceous dark brownish black V, sides dark brown shading into the black apical third. Cerci pale brown as are the paraprocts. Ovipositor black. Sternite of seg. 8 dark brown with black keel and edged above along sides with black. Sternites 3–7 black and yellow following the color of sides, wholly yellow in seg. 1 but in seg. 2 yellow with a narrow midventral keel black.

Described in detail because based on one very poorly preserved female lacking tibiae and tarsi of the forelegs.

In the key of Calvert's (1931) monograph this female by thoracic color runs (p. 31) to the group including *nathalia* (Guatemala to Venezuela) with 20–26 postnodals from which it differs in its very few postnodals (13–14); *clementia* (Colombia, Venezuela) from which it differs in its entirely pale venter back of hind legs and in the larger number of postnodals, 18–23 in *clementia; croceicauda* (Colombia) with 15–17 postnodals and orange on dorsum of abdominal segs. 8–10; and *melanota* (?) (Costa Rica) with 15–17 postnodals.

On first study we related it to the female of *croceicauda* because of the similarity in thoracic color pattern (Calvert, 1931, Pl. XXI, fig. 99). *Melanota* was overlooked because (Calvert, 1931, Pl. XXI, fig. 102) the latter had no apparent humeral blue stripe and the lateral blue stripe was too wide and diffuse. We had not discovered the two blue spots on abdominal seg. 9.

At this point we went to Ann Arbor and studied the female of *croceicauda* in the Williamson Collection. Our sketches of *croceicauda* were made then. *Melanota* was not studied.

On returning to Columbus we checked the blue colors of *melanocauda* by moistening the specimen with "house-hold" ammonia water, a trick learned by Mrs. Gloyd in her study of the blues on Argias. Immediately the blue humeral stripe was clearly extended to the mesinfraepisternum and the two blue spots appeared on seg. 9 (not even suspected before). The pale sides of the prothorax showed faint blue tints. After drying the lateral stripes lost all blue and the humeral stripes were dimmer than before ammonia was used. Calvert did not use ammonia (supposed by Mrs. Gloyd not to injure the color pattern) as his work was done before this discovery at Ann Arbor. This makes me wonder if *melanota* may not have had narrow obscured humeral stripes in the material studied by Calvert. If so, our female may be that of *melanota*. However, the female of *melanota* collected by Calvert himself and preserved in alcohol should have shown such a humeral stripe, if present. Thus our female differs from *melanota* in lacking the humeral stripe. It resembles that female in thoracic color otherwise, in two pale spots on the postclypeus and in the two oval blue spots on seg. 9. It is decidedly smaller as the abdomen in *melanota* is 35 mm., the hind wing 24.5–25.5 mm. and the postnodals are 15–17 (13–14 in *melanocauda*).

Obviously ammonia should be used with caution on the delicate and fugitive blues of Palaemnema. In Argia blue colors stand out like enamel and are probably more dense and of greater depth.

Palaemnema croceicauda Calvert

(Figs. 15–18)

In our study of the female of *croceicauda*, while still in the belief that *melanocauda* was its closest relative, we made the sketches showing color patterns. We introduce them for the use of future students of *Palaemnema*. White (unstippled) represents blue, light stipple, yellow. The browns and blacks are in heavy stipple. See Calvert, 1931, pp. 102–103 for further notes on color.

LITERATURE USED

Calvert, P. P. 1931. The Generic Characters and the Species of Palaemnema (Odonata: Agrionidae). Trans. Amer. Ent. Soc., 57: 1–110, 21 pls.

Calvert, P. P. 1934. Two Mexican Species of Palaemnema. Trans. Amer. Ent. Soc., 59: 377–381. (Further records of species in Calvert, 1931.)

Cowley, J. 1934. Notes on Platystictidae (Odonata) of the Neotropical Region. Stylops 3 (9): 201–204, figs. 1–12. (*martini.*)

Kennedy, C. H. 1938. *Palaemnema picicaudata*, *P. abbreviata* and *P. brucelli*, New Dragonflies from Ecuador, with Notes on Other Palaemnemas. Ann. Ent. Soc. Amer. 31 (2): 249–266, 48 figs.

Kennedy, C. H. 1940. *Palaemnema joanetta*, a New Dragonfly from Panama. Ann. Ent. Soc. Amer. 33 (4): 626–628, 8 figs.

A CLASSIFICATION OF THE SCALE INSECT GENUS ASTEROLECANIUM, by Louise M. Russell. 322 pages, 9 plates and 84 text figs. 1941. Size 6 x 9 inches, paper bound. Published as Misc. Publ. No. 424 of the U. S. Dept. of Agr. Price 45 cents. For sale by the Superintendent of Documents, Washington, D. C.

This is a monograph based on National Museum material but also on generous loans from nearly all the leading specialists of the world. Each of the eighty-four text figures is really a full page plate in line drawing with frequently fifteen to twenty items under the one serial number. These line drawings are by Sara Hoke DeBord. The nine plates are an arrangement of one hundred sixty-seven photographs of these scales with few duplications. They were made by M. Foubert of the Department of Agriculture and are a set of remarkably clear illustrations.

From the author's mathematics on page 2 there appear to be about one hundred and fifty species in the genus. If we have failed to solve the author's subtractions and additions, we will remark that over two hundred pages fairly overflow with species descriptions. There are twenty-four pages of keys, ten of which are keys to larvae. Pages 8 to 11 carry a discussion of the twelve groups into which the genus appears to be divided. The index is an alphabetical list of species.

This volume shows what the expert taxonomists of the Bureau can do when they have sufficient spare time. We always hope that more time can be found for monographic work. Such publications help all extra-Bureau specialists to identify their own material. It is an excellent work.—C. H. K.

STUDIES OF THE GENUS EMPOASCA

(Homoptera, Cicadellidae)

PART VIII[1]

SIX NEW SPECIES OF EMPOASCA FROM SOUTHWESTERN UNITED STATES, MEXICO, AND CHILE

RALPH H. DAVIDSON
AND
DWIGHT M. DELONG

Empoasca lauta n. sp.

Resembling *pallidula* in color and appearance but smaller in size and with characteristic dorsal spine. Length 3 mm.

External characters.—Vertex broadly rounded, almost transverse, and slightly less than twice as wide between eyes as median length. Color whitish, mottled with darker spots. Vertex with a whitish median line and a pale spot next to each eye. Pronotum whitish, with two large median spots and two smaller spots on each side which are light yellow. Scutellum pale yellow. Elytra whitish, subhyaline, with darker smoky spots, especially near the apices. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes rather short, apical fourth narrowed and pointed at the apex. Aedeagus enlarged a little more than half its length forming an anteriorly projecting process and a dorsally produced portion which is rounded at the apex. Spine of ninth segment broad, narrowed on anterior and posterior margins to form a short narrow apical portion which extends ventrally and bears three teeth at apex. The anterior tooth is longer and sharp pointed, the median tooth short and blunt, and the posterior one is also blunt and much shorter.

Holotype male, allotype female, and one female paratype from Palm Springs, California, 5–19–41; and one female paratype from Tucson, Arizona, 5–13–41; all collected by Professor and Mrs. J. N. Knull and deposited in the collection of the authors.

Empoasca ulusa n. sp.

Resembling *unca* in size and appearance but with characteristic dorsal spine and much smaller but similar type of lateral processes. Length 3.5 mm.

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[1] Previous parts of this study have appeared as follows: Ohio Jour. Sc., 32: 393–401; 35: 29–39; 36: 225–230; 38: 90–96; 39: 110–118; and Ann. Ent. Soc., 27: 604–609; 33: 608–611.

External characters.—Vertex blunt, pointedly produced, and about two-thirds as long at middle as basal width between the eyes. Color pale yellow to milky white. Vertex, pronotum and scutellum pale yellow, anterior portion of pronotum with three or more broad white blotches. Elytra milky white, subhyaline. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes short, slender, with a short spine-like tooth on outer margin of apex. Aedeagus abruptly enlarged two-thirds its length on inner margin forming a pointed triangular apical process which has a pointed basal angle extending anteriorly and a pointed dorsal apex. Spine of ninth segment broad, with a short, pointed tip directed downward on ventro-anterior portion.

Holotype male and allotype female collected in Santa Rita Mountains, Arizona, by Professor and Mrs. J. N. Knull on August 16, 1940. Male and female paratypes from the type locality and from the following sections of California: Chester, (6–12–41); Monterey County, (6–24–41); and San Benito County, (8–9–40); all collected by Professor and Mrs. Knull. Types in the collections of the authors.

Empoasca arqua n. sp.

Resembling *pallidula* in coloration but smaller in size and with characteristic internal male genitalia. Length 2.5 mm.

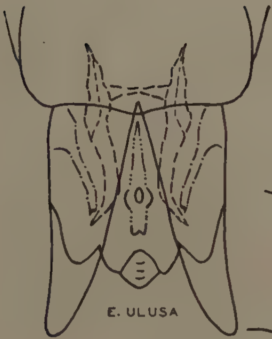
External characters.—Vertex blunt at apex, not strongly produced, a little wider between eyes at base than median length. Color greenish with dark mottled areas. Vertex greenish to yellow, with a whitish spot at apex and a median white line continuous to pronotum, and a pale spot next each eye at base. Pronotum dull smoky green, with three pale areas on anterior margin and a pale median stripe. Scutellum pale green. Elytra very pale green with rather large areas margined with smoky pigmentation. Apical portion smoky with pale veins. Female last ventral segment produced and broadly rounded on posterior margin.

Internal male genitalia.—Lateral processes rather long, sinuate, and narrowed to slender apices which are curved slightly dorsally and outwardly. Aedeagus abruptly enlarged at three-fourths its length with a rounded apex. Spine of ninth segment rather long, tapered to a short pointed tip, directed ventrally and curved slightly anteriorly.

Holotype male and allotype female and four female paratypes collected in Palm Springs, California, 5–19–41, by Professor and Mrs. J. N. Knull. Types deposited in the collections of the authors.

Empoasca ingena n. sp.

Resembling *obstipa* in size and shape of lateral processes but with characteristic coloration and projection on aedeagus. Length 3.5 mm.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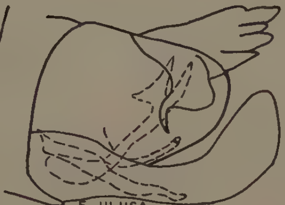
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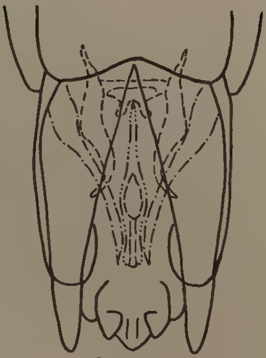
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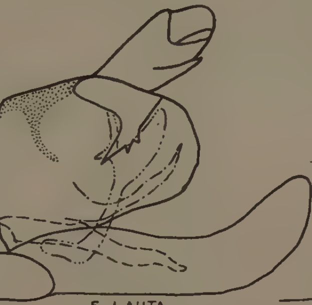
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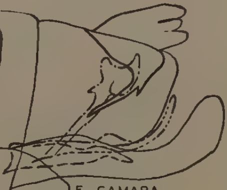
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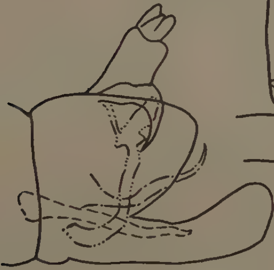
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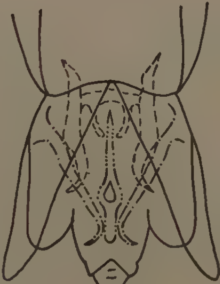
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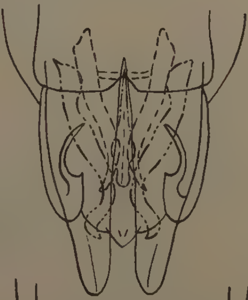
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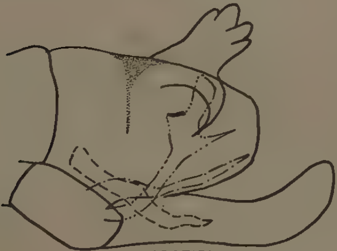
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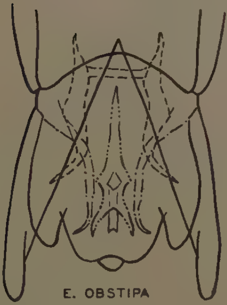
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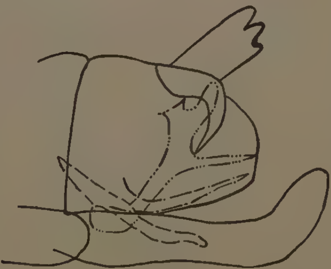
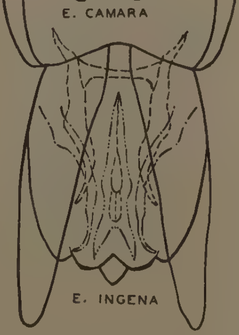

E. INGENA


E. INGENA

External characters.—Vertex bulbous, roundedly produced, more than one-third wider between eyes than median length. Color pale to white marked with red to brownish spots. Vertex with a pair of reddish longitudinal stripes extending from ocelli to base of vertex and continuous on pronotum to scutellum. Elytra marked with large reddish blotches, with an irregular transverse brownish band across apex of clavus. Apical third of elytra smoky.

Internal male genitalia.—Lateral processes narrow, tapered to pointed apices which are curved outwardly. Aedeagus in ventral view with a pair of heavy, posteriorly projecting, divergent spines attached at base of apical third. In lateral view these are much longer than in *obstipa*, extending to caudal margin of pygofer. The apex of aedeagus is narrowed, produced and rounded. The spine of ninth segment is broad at base strongly concavely rounded on anterior margin and rapidly tapered to an anteriorly curved pointed apex.

Holotype male from Barranca, Mexico, 2–16–26 (Dampf); a male paratype from Coscomatepec, 9–30–24 (Dampf); and a male paratype from Toluea Rd., Mexico, 2–24–38 (Caldwell), all deposited in collection of authors.

Empoasca obstipa n. sp.

Resembling *amara* in size, general appearance, and shape of lateral processes, but with characteristic posteriorly projecting portion of aedeagus. Length 3.5 mm.

External characters.—Vertex blunt, roundedly produced, decidedly wider between eyes than median length. Color bright green with paler green markings. Vertex with paler longitudinal green markings. Elytra with hyaline areas along veins, apical third smoky. Female last ventral segment roundedly produced.

Internal male genitalia.—Lateral processes long, slender, tapered to pointed apices which are curved outwardly at tips. Aedeagus narrow at base, enlarged near apical third with a pair of stout posteriorly projecting spines at base of enlargement. Apex broader than basal portion with a broadly rounded or truncated tip. Spine of ninth segment short, tapered and sharply pointed, curved ventrally and anteriorly.

Holotype male, allotype female and a large series of male and female paratypes from Barranca, Mexico, 2–16–26 (Dampf); Popotla, Mexico, 6–19–24 (Dampf); and Toluea Rd., Mexico, 2–24–38 (Caldwell), all deposited in the collections of the authors.

Empoasca camara n. sp.

Resembling *mexicana* and *curveola* in shape of lateral processes but with a distinct spine which is similar to that of *curveola* Oman. Length 3.5 to 4 mm.

External characters.—Color similar to *curveola*, greenish washed with yellow. Elytra greenish hyaline. Vertex bluntly, bulbously produced, about twice as wide between eyes as median length. Female segment roundedly produced.

Male internal structures.—Lateral processes in lateral view curved upward at apex; in ventral view converging to near apex where they are abruptly curved outwardly with inwardly curved and pointed apices. Aedeagus enlarged at apex with an upwardly rounded tooth on anterior edge and a bluntly pointed posterior tooth, between which the dorsal margin is broadly concavely rounded. Spine of ninth segment long, curved sharply anteriorly tapered to a long slender pointed tip and with a pointed spur on posterior margin at about half its length.

Holotype male, allotype female, and two female paratypes, all from Santiago, Chile, and deposited in the Herbert Osborn Collection, Ohio State University.

MOSQUITO CONTROL. PRACTICAL METHODS FOR ABATEMENT OF DISEASE VECTORS AND PESTS, by W. B. HERMS and H. F. GRAY. xii 317 pp., 60 figures. THE COMMONWEALTH FUND, 41 East 57th St., New York. 1940. Price $3.50.

The nuisance importance of mosquitoes is recognized by everybody and their function as vectors of disease is gradually becoming common knowledge. Hence these insects, like rattlesnakes, are highly and justly unpopular with the public. Mosquito control annually requires the activities of many people and the expenditure of large amounts of money. In order to make efforts effective and money well spent an entomologist and an engineer, who have collaborated for many years, have written a guide for the benefit of those individuals who are concerned with the mosquito problem.

The following list of titles should not only indicate the contents of this guide but also briefly impress upon our minds the variegated nature of its subject. The contents are: Introduction; Economic importance of mosquitoes; Laws and agencies for mosquito abatement; Preliminaries to abatement procedures; Education of the public; Finding mosquito breeding places; Abatement methods, general principles; Drainage and reclamation of fresh-water marshes; Drainage and reclamation of salt-water marshes; Filling, pumping, and flushing; Oils and larvicides; Methods of application of oils and larvicides; Mosquito control by use of fish; Supplementary protective measures; Special features of mosquito control in urban areas; Special features of mosquito control in rural areas; Species sanitation and naturalistic control; The principal malaria-transmitting anophelines of the world; Suggestive associations of mosquitoes grouped according to typical larval habitat; Classification of mosquito abatement methods; Selected list of books and articles on mosquito species and biology; and Index. There is a bibliography at the end of most of the chapters.

The widespread usefulness indicated by the titles is amply proven in the text. There is information for the economic entomologist whether engaged in teaching or mosquito abatement; for teachers in a variety of fields and specifically in public health and sanitary engineering. A main item in most abatement programs is financial and throughout the book methods for computing cost are given and they are usually illustrated with actual examples. The fear of cost should not deter action in a given situation until the problem has been studied because remedial measures are frequently inexpensive. It would be impossible, without showing partiality, to illustrate the book's value by citing additional examples for this guide is uniformly excellent and complete in all respects. It is an obligation to point out, however, that in the public relations aspects of mosquito control it is superb.—C. E. VENARD.

CARTERETTA CARTERI CLAVATA, A NEW SUBSPECIES FROM NEVADA, AND NOTES ON SYNONYMY (SIPHONAPTERA)[1]

Newell E. Good
Associate Entomologist, United States Public Health Service
San Francisco, Calif.

Among the ectoparasites collected for identification during routine plague survey operations in Western United States there was found a pair of fleas closely related to, but not identical with, the species described by Fox in 1927 as *Carteretta carteri*. These specimens are here described as a new subspecies of *C. carteri*.

Carteretta carteri clavata new subspecies

Male and Female. Head—Shape of head, number and position of bristles of preantennal region, and spines of genal comb as in *C. carteri* C. Fox 1927. Eyes vestigial, rather lightly pigmented, tapering to a narrow point ventrally and partially merged with the posterior genal margin. Labial palpus extending three-fourths of the length of the fore coxa. Bristles on occiput as follows: upper or anterior row 4 (male) or 5 (female); lower or posterior row 5 (male) or 6 (female).

Thorax—There are 16 spines in the pronotal comb, but in the male the lower spine on each side is small. The length of the hind femur is 0.38 mm. (male), and 0.39 mm. (female).

Abdomen—There are apical spines on the abdominal tergites as follows (on the two sides together): Male—Tergite I=6, II=8, III=6, IV=4, V=2; female—I=5, II=5, III=2, IV=3, V=0. The basal abdominal sternite bears, on either side near the middle, a single hair on the male, and a patch of fine bristles or hairs on the female. The abdominal sternites bear ventrally the following number of bristles: (male)—basal=2, III to V=5 each, VI to VII=6 each, VIII=6 on each side; (female)—basal=2, III to VI=8 each, VII=13. There are 3 antepygidial bristles (A. P. br.) on each side in both the male and female. Unfortunately in the type (male) the lower two on each side are broken. The average lengths of the antepygidial bristles on the two sides in the allotype (female) are as follows: upper or inner=0.11 mm., middle=0.27 mm., outer or lower=0.24 mm. The pygidium (Pyg.) is nearly straight above in the male, but moderately convex in the female.

Modified segments. Male—The upper process of the clasper is much less prominent than in *C. c. carteri* and the sinus separating the processes is very shallow. The upper process bears two large bristles and a hair. The movable finger (F) of the clasper is shorter (total length 0.195 mm.), and more club-shaped than in *C. c. carteri*, being enlarged distally on both dorsal and ventral margins. The apex is more pointed and the pair of heavy bristles are placed farther from the apex. The manubrium (M) of the clasper is shorter and much more curved than in *C. c. carteri*. In the internal paramere (Par) of the penis the ventral process is less slender than in *C. c. carteri* and has a much more pronounced apical hook. The dorsal process of the paramere bears two pointed teeth or thorn-like projections on the antero-dorsal margin and is sharply and obliquely cut off at the apex. The external paramere is much smaller and narrower than in *C. c. carteri* and bears a deep sinus terminally. The internal part of sternite IX is sinuate along the posterior margin. The external part is shorter than in *C. c. carteri*, the length along the dorsal margin from elbow to apex being 0.13 mm., while that of *C. c. carteri* from Monterey County averages 0.185 mm. The apical one-half of sternite IX is straight on the dorsal margin and convex ventrally. Each side of sternite IX bears two hairs and a bristle near the apex and another bristle and a small hair about one-third of its length from the apex.

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[1] From the Plague Suppressive Measures Laboratory, San Francisco, Calif.

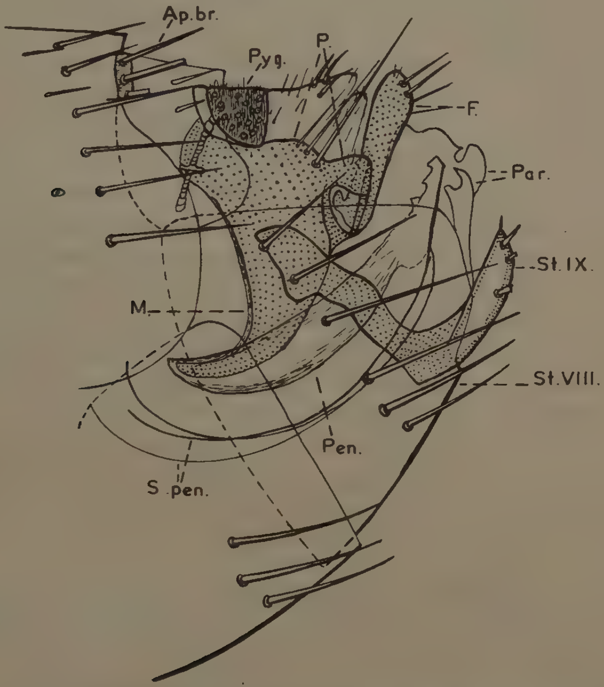

Fig. 1. *Carteretta carteri clavata* new subspecies, male, modified segments. × 112.

Abbreviations.—Ap. br., antepygidial bristles; F., movable finger of clasper; M., manubrium of clasper; P., immovable process of clasper; Par., paramere of penis; Pen., penis; Pyg., pygidium; S. pen., spring of penis; St., sternite.

Modified segments. Female—The stylet is 4 times as long as broad at the base and bears one long terminal bristle and one subapical and one lateral bristle. Unfortunately the receptaculum seminis in our specimen is turned directly upwards, i. e., crosswise in the specimen. It appears, however, to be smaller (diameter of head 0.075 mm.), the head more globular and its surface more granulated, and the tail shorter and broader than in *C. c. carteri*. Sternite VII is broken in the allotype. Sternite VIII is somewhat larger than in *C. c. carteri*, and its apex terminates in a rather blunt point. Each side of this sternite bears about 10 large bristles and about 12 smaller bristles arranged irregularly. Sternite X or the anal sternite bears 3 bristles on either side at the ventral angle as in *C. c. carteri* but they are less closely bunched and the anterior bristle is much thinner than the other two.

Total length—(male) 2.13 mm.; (female) 2.75 mm.

Described from the holotype male and allotype female.

Type locality.—Clark County, Nevada.

Type host.—*Peromyscus* sp. (*truei* Shufeldt ?).

Holotype male collected 23 miles northwest of Las Vegas, Clark County, Nevada, elevation 2400 feet, April 16, 1938, from *Peromyscus* sp. (*truei* ?). Allotype female collected 20 miles northwest of Las Vegas, Clark County, Nevada, elevation 2160 feet, April 9, 1938, from *Peromyscus eremicus*. Both specimens were collected by F. J. Gonderman of the United States Public Health Service Plague Survey. Holotype and allotype in the collection of the United States Public Health Service, Plague Suppressive Measures Laboratory, San Francisco, California.

Carteretta C. Fox

1927. *Carteretta* C. Fox. Trans. Amer. Ent. Soc. 53: 209.
Synonym: *Trirachipsylla* Stewart 1940 (Pan-Pac. Ent. 16: 23–24).

Carteretta carteri carteri C. Fox 1927

1927. *Carteretta Carteri* C. Fox, Trans. Amer. Ent. Soc. 53: 209–210. 1 male from *Neotoma fuscipes*, Los Angeles, California.

Feb. 10, 1940. *Trirachipsylla digitiformis* Stewart, Pan-Pac. Ent. 16: 24–25, figs. 13, 14, 15. Males and females from *Perognathus californicus* and *Peromyscus truei*, Monterey County, Calif. Description of male and female. Holotype male and allotype female from *Perognathus californicus*.

March 22, 1940. *Carteretta carteri* C. Fox, Jellison, Pub. Health Repts. 55: 489–490, fig. 1. Males and females from *Perognathus californicus*, *Peromyscus maniculatus*, and *Peromyscus truei*, Monterey County, California. Description of female. Allotype from *Peromyscus maniculatus*.

The specimens used by Stewart and those used by Jellison were obtained at the same location, i. e., the Hastings Natural History Reservation, near Jamesburg, Monterey County, California. The present writer had the opportunity of studying the specimens used by Jellison and of comparing a male of this series with the type specimen of *C. carteri* at the U. S. National

Museum, in November, 1939, and feels that the following notes may be of value.

In the Monterey County specimens, the eye is somewhat more heavily pigmented than in the type. The "close set row of short hairs along posterior margin of antennal groove," mentioned by C. Fox in his original description, actually consists, in both the type and in most of the Monterey County specimens, of two unevenly spaced close set rows of small, fine spinulets.

The movable finger of the clasper is of the same length in the Monterey County specimens as in the type (0.24 mm.), but the width of the movable finger is somewhat greater in the former than in the type. The average greatest width, through the club, of Monterey County specimens used by Jellison is 0.044 mm., while that of the type is 0.037 mm. The manubrium of the clasper of Monterey County specimens is somewhat longer and more sharply upturned at the extreme tip than in the type, the relative lengths being 25 to 22 for Monterey County males and the type male, respectively.

There appear to be no other differences or significant variations between the type and specimens from Monterey County. The writer feels that these fine distinctions are definitely of less than specific value and are unlikely even to be of subspecific value. If, when some topotypes of *C. carteri* are obtained, it is found that the slight variations given above prove constant and of subspecific value, the name *digitiformis* Stewart will be available.

THE NATURAL WAY TO DRAW, by KIMON NICOLAIDES, pages xiv and 221, 150 illustrations. 1941. 7½ x 10½ inches, linen. Published by HOUGHTON MIFFLIN CO., 2 Park St., Boston, Mass. Price, $3.00.

The editorial interest in drawing and particularly in scientific illustration led to the purchase of a copy of "The Natural Way to Draw." Kimon Nicolaides, for fifteen years the leading instructor in drawing at the New York Art Students' League, has received many glowing review notices on his manual which was only in rough draft at the time of his early death in 1938. It has been completed from his teaching notes. Some of the critics have rated Nicolaides as one of the very great teachers of drawing in the history of art. He had the unique ability to get each student to express his or her own personal feelings and to develop a personal style or technique. In Nicolaides classes no two students arrived at the same result. Each put his own interpretation into his particular drawing. Thus the great teacher's instruction dealt with expression, not of form or arrangement as much as it did with the expression of movement and of emotion. He dealt with poses and gestures, not with reliefs and contours.

We have written enough concerning a remarkable teacher and of the volume outlining his methods to warn our readers that the book is of little value to a draftsman in science. It is an interesting work because it endeavors to develop a mastery over drawing to that point where it becomes something else than draftsmanship, to where it passes over into a fine art.—C. H. K.

THE ENTOMOLOGICAL SOCIETY OF AMERICA

PROCEEDINGS OF THE THIRTY-SIXTH ANNUAL MEETING

San Francisco, California, December 29, 1941-January 1, 1942

The Entomological Society of America held its Thirty-sixth Annual Meeting on Monday, Tuesday, Wednesday and Thursday in the St. Francis Hotel. This was the first time the Annual Meeting occurred in a separate city from that designated by the American Association for the Advancement of Science.

Monday morning a joint session was held with the Teaching Section of the American Association of Economic Entomologists. The program was in the nature of a symposium on "The Training of Entomologists." Two general subjects were discussed: "What Service Courses Should Be Offered in Entomology for Non-professional Students?" and "An Ideal Undergraduate Training for Professional Entomology." Dr. Stanley B. Freeborn presided.

The annual joint symposium arranged by our Society and the American Association of Economic Entomologists was held Monday afternoon. The subject was "The Relation of Taxonomy to Economic Entomology." Professor T. D. A. Cockerell presided and introduced the speakers. Professor E. O. Essig discussed "The Significance of Taxonomy in the General Field of Economic Entomology." Mr. C. F. W. Muesebeck, Dr. A. M. Boyce, and Mr. C. P. Clausen each discussed some of the fundamental taxonomic problems involved in certain selected fields of economic entomology. Dr. T. H. Frison closed the symposium with a discussion of "The Significance of Economic Entomology in the Field of Insect Taxonomy." The close and fundamental relationships existing between these two fields were emphasized by all the speakers and resulted in a better appreciation and understanding by all who were present of the dependence of the one upon the other.

The Annual Public Address of the Society was held at the California Academy of Sciences in Golden Gate Park, Monday evening. The address was given by Professor G. F. Ferris of Leland Stanford University. An abstract of the address on "Insect Morphology and Evolution" follows:

"Geneticists and other experimental biologists who are interested in the problems of evolution are unable to carry their investigations beyond the limits of the species, since the technique of hybridization upon which they are dependent cannot be applied beyond that point. Yet, as Goldschmidt has remarked, 'The laws which are supposed to explain the diversification of species must also account for families, orders and phyla . . . ' and in the attempt to arrive at some understanding of these laws we must proceed by the methods of the comparative anatomist. It is the contribution which can possibly be made by the student of the comparative anatomy of the Arthropoda that we shall here consider.

"For various reasons we do not now have a sound body of knowledge concerning the comparative morphology of the Insecta. The reasons are in part to be found in the historical development of Entomology and in part in the enormous abundance of material that is presented to us by the hundreds of thousands of insect and other Arthropodan species. This abundance of material has been especially important, since it has led to fundamental misconceptions concerning the 'plasticity' of insect structure and the capacity of this structure to respond to the 'pressure of the environment.'

"It is the contention here maintained that in attempting to develop a sound comparative morphology of the Insecta it is necessary, first of all, to establish a body of sound, controlling principles and to adhere to a rigid discipline. Two fundamental principles, for example, are these. First: every structure must be seen and seen correctly. Second: every structure must be accounted for morphologically. There are other principles and basic assumptions that must also be established. The discipline consists of an undeviating adherence to these principles.

"When these principles are recognized and the necessary accompanying discipline is maintained we find that the morphology of the Insecta falls into a simple and internally consistent system of fundamental patterns. Each of these patterns is derived from an antecedent pattern, for the most part through processes which involve change in the shape or proportions of parts, or consolidation of parts, or loss of parts. The addition to the pattern of anything that is totally new is an occurrence of comparative rarity. The great diversity of insect form has been achieved not by any great 'plasticity' of fundamental structure, but by mere alteration of details. The head capsule of the most highly modified insect is explainable on the basis of structures that are fully developed in the head capsule of the Symphyla, with the sole exception of the eyes which have perhaps been secondarily lost in the latter group.

"The work already done in accord with the principles and the discipline previously mentioned suggests that evolution in the Insecta has not been merely a process of change. It has involved also the fixing of limits beyond which change seems not to proceed except by loss. The fixing of these limits has resulted in the setting up of a comparatively small number of fundamental patterns. Within these minor patterns have been established. The possibilities of evolution have thus become progressively restricted. For this process the descriptive phrase, 'the sequential stabilization of genetic patterns,' is suggested.

"The view that comparative morphology has anything to do with the function of the structures involved is here rejected. The opinion is maintained that functional needs have done nothing more than to take the material offered to them by the evolutionary capacities which are inherent in the genetic materials of the organism and which are confined within limits that are inherent in those materials, and then by the processes of selection to make the best of them. The fundamental structure is not thereby altered.

"These are suggestions which remain to be tested by future morphological work.

"The thesis is maintained that if we can arrive at a proper treatment of the enormous mass of material offered to us by the Arthropoda we should be able to see what happens after evolutionary processes have passed beyond the limits of the species and thus beyond the ken of the geneticist and experimentalist. We should be able to test any evolutionary hypothesis that may be proposed and we should be able to make a genuine contribution to the advancement of biological theory." G. F. FERRIS.

The Public Address was followed by an informal reception in the African Hall of the California Academy of Sciences where refreshments were served. Many of those in attendance took advantage of the occasion to visit the insect collections of the Academy. Approximately five hundred persons attended the Public Address and the Informal Reception. All were grateful to the California Academy of Sciences for a most interesting session and for the excellent social evening, as well as to the local committee for arranging transportation facilities for the occasion.

The Taxonomists' Conference which was such a successful feature of the Philadelphia meeting in 1940 was scheduled for a second session at San Francisco on Tuesday afternoon. The topic discussed was, "Genotype Fixation." Mr. C. F. W. Muesebeck led the discussion. A very profitable afternoon was spent in the consideration of the numerous problems which arise in connection with this phase of nomenclature. The Society is indebted to Mr. Muesebeck for his leadership and guidance in the presentation of all sides of this taxonomic question. The attendance at the session was gratifying and the participation of a large number of those in attendance gave the discussion an added interest.

Thursday was given over to a tour of the University of California at Berkeley and Golden Gate Park in San Francisco. The Division of Entomology and Parasitology held open house Thursday morning on the Berkeley campus. The visitors were escorted by members of the Graduate Club of the Division and had the privilege of viewing most interesting and instructive exhibits of the various entomological projects under way. Luncheon was served at the International House, and this was followed by a visit to Golden Gate Park.

The Entomologists' Dinner was held on Thursday evening at the Sir Francis Drake Hotel with three hundred or more persons in attendance. This was a most successful social occasion and offered a fitting climax to the week's activities.

The attendance at San Francisco was surprisingly good in view of the adverse conditions which prevailed on account of the Pearl Harbor attack just three weeks before.

The program presented at the four day meeting follows:

Opening Session, Monday Morning, December 29

The Society was called to order at 9:30 A. M. by President W. B. Herms in the Italian Room of the St. Francis Hotel. President Herms appointed the following committees:

Nominating Committee—E. O. ESSIG, *Chairman;* F. L. CAMPBELL, G. F. KNOWLTON.

Resolutions Committee—L. HASEMAN, *Chairman;* E. G. LINSLEY, P. W. OMAN.

Auditing Committee—MYKOLA HAYDAK, *Chairman;* HOWARD O. DEAY, RAYMOND C. OSBURN.

President Herms introduced Dr. STANLEY B. FREEBORN, *Chairman* of the Teaching Section of the American Association of Economic Entomologists who presided at the joint session of the Teaching Section and our Society.

The following papers were presented:

THE TRAINING OF ENTOMOLOGISTS

A. What Service Courses Should Be Offered in Entomology for Non-professional Students?
  1. For General Agricultural Students. (10 min.) J. R. EYER, New Mexico College of Agriculture, State College, New Mexico.
  2. For Students of Forestry. (10 min.) K. A. SALMAN, Bureau of Entomology and Plant Quarantine, Berkeley, California.
  3. For Medical Students. (10 min.) W. B. HERMS, University of California, Berkeley, California.
  4. For General Biology Students. (10 min.) HARLOW B. MILLS, Montana State College, Bozeman, Montana.

B. An Ideal Undergraduate Training for Professional Entomology.
  1. As Terminal Training. (15 min.) CLAY LYLE, Mississippi State College, State College, Mississippi.
  2. As a Preparation for Graduate Work. (15 min.) S. A. GRAHAM, University of Michigan, Ann Arbor, Michigan.

The Society then adjourned to meet with the American Association of Economic Entomologists to hear the address of their PRESIDENT, DR. J. R. PARKER.

Second Session, Monday Afternoon, December 29

JOINT SESSION WITH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

SYMPOSIUM

"The Relation of Taxonomy to Economic Entomology"

The Session was called to order at 2:00 P. M. by PROFESSOR T. D. A. COCKERELL. The following papers were presented:

The Significance of Taxonomy in the General Field of Economic Entomology. (30 min.) E. O. ESSIG, University of California, Berkeley, California.

Fundamental Taxonomic Problems in Selected Fields of Applied Entomology.
  Plant Quarantine and Nursery Inspection. (20 min.) C. F. W. MUESEBECK, Bureau of Entomology and Plant Quarantine, Washington, D. C.
  Chemical Control. (20 min.) A. M. BOYCE, Citrus Experiment Station, Riverside, California.
  Biological Control. (20 min.) C. P. CLAUSEN, Bureau of Entomology and Plant Quarantine, Washington, D. C.

The Significance of Economic Entomology in the Field of Insect Taxonomy. (30 min.) T. H. FRISON, Illinois Natural History Survey, Urbana, Illinois.

Third Session, Monday Evening, December 29

The Session was called to order by PRESIDENT W. B. HERMS at 8:00 P. M. in the hall of the California Academy of Sciences. President Herms introduced the speaker of the evening, PROFESSOR G. F. FERRIS of Leland Stanford University, who spoke on the subject "Insect Morphology and Evolution."

Fourth Session, Tuesday Morning, December 30

The Session was called to order by President W. B. HERMS at 10:00 A. M. and the following papers were presented:

1. The Primary Larva and Systematic Position of the Meloid Genus *Poreospasta* (Coleoptera.) (5 min.) (Lantern.) J. W. MACSWAIN, University of California, Berkeley, California.
2. The Distribution and Origin of the Osmiine Bees Adapted to the Deserts of North America. (15 min.) CHARLES D. MICHENER, University of California, Berkeley, California.
3. Macroveliidae, a Proposed New Family of Semi-aquatic Hemiptera. (10 min.) (Lantern, 2x2.) ARTHUR P. MCKINSTRY, University of California, Davis, California.
4. Concerning the Distribution of Some American Corixidae. (10 min.) (Lantern.) H. B. HUNGERFORD, University of Kansas, Lawrence, Kansas.
5. Some Entomological Aspects of Mosquital Transmission of the Virus of Equine Encephalomyelitis. (15 min.) W. B. HERMS, University of California, Berkeley, California.
6. An Authentic Attack on Humans by the Screwworm, *Cochliomyia americana* C. and P. (10 min.) (Lantern, 2x2.) L. HASEMAN, University of Missouri, Columbia, Missouri.
7. Seasonal History Studies of Some Minnesota Phalaenidae (=Noctuidae.) (10 min.) (Lantern.) HERBERT KNUTSON, University of Minnesota, St. Paul, Minnesota.
8. Host Plant Records of Cercopidae in North America, North of Mexico (Homoptera). (5 min.) KATHLEEN DOERING, University of Kansas, Lawrence, Kansas.
9. The Life History of *Trichodes ornatus*, a Larval Predator in the Nests of Bees and Wasps. (10 min.) (Lantern.) E. G. LINSLEY and J. W. MACSWAIN, University of California, Berkeley, California.

Fifth Session, Tuesday Afternoon, December 30

The Session was called to order by Mr. C. F. W. MUESEBECK at 2:00 P. M.

An informal discussion of the topic "Genotype Fixation" was participated in by the members.

Sixth Session, Wednesday Morning, December 31

The Session was called to order by PRESIDENT W. B. HERMS at 10:00 A. M. and the following papers were presented:

10. New Species of the Genus *Halictophagus* with a Key to the Genus in North America (Halictophagidae, Strepsiptera.) (10 min.) (Lantern.) RICHARD M. BOHART, University of California, Los Angeles, California.
11. Observations on Eriophyid Life Histories. (20 min.) (Lantern.) H. H. KEIFER, State Department of Agriculture, Sacramento, California.
12. Notes on the Classification of the Reduviidae with a New Subfamily from South America. (10 min.) (Lantern, 2x2.) ROBERT L. USINGER, University of California, Davis, California.
13. The Osmotic Pressure of the Blood of Several Insect Species. (15 min.) E. N. FELS and W. M. HOSKINS, University of California, Berkeley, California.
14. Ovulation in Relation to Oviposition in the Parasitic Hymenoptera. (20 min.) (Lantern.) STANLEY E. FLANDERS, Citrus Experiment Station, Riverside, California.
15. Cuticular Permeability and Its Relationship to Toxicity. (15 min.) M. RICKS and W. M. HOSKINS, University of California, Berkeley, California.
16. A Comparative Study of the Appendages of the Eighth and Ninth Abdominal Segments of Insects. (15 min.) (Lantern.) CHARLES D. MICHENER, University of California, Berkeley, California.
17. A Convenient Cage for Confining Sucking Insects to Plants in Connection with Injury Studies. (5 min.) (Lantern.) JOHN T. MEDLER, New Mexico College of Agriculture, State College, New Mexico.

Seventh Session, Wednesday Afternoon, December 31

The Session was called to order at 2:00 P. M. by PRESIDENT W. B. HERMS, and the following papers were presented:

18. Some Observations on the Structure of the Insect Head. (20 min.) (Lantern.) G. F. FERRIS, Natural History Museum, Stanford University, California.
19. The Musculature of the Labrum, Labium and Pharyngeal Region of Adult and Immature Coleoptera. (15 min.) (Lantern, 2x2). C. K. DORSEY, Bureau of Entomology and Plant Quarantine, Gulfport, Mississippi.
20. Emergence of *Chaoborus astictopus* D. and S. from Clear Lake. (10 min.) ARTHUR W. LINDQUIST and CHRISTIAN C. DEONIER, Bureau of Entomology and Plant Quarantine, Nice, California.
21. Biology of the Immature Stages of the Clear Lake Gnat, *Chaoborus astictopus* D. and S. (10 min.) CHRISTIAN C. DEONIER, Bureau of Entomology and Plant Quarantine, Nice, California.
22. A Taxonomic and Distributional Study of Simuliidae of Western United States. (By title.) GEORGE S. STAINS and G. F. KNOWLTON, Utah Agricultural College, Logan, Utah.
23. Swimming and Burrowing Activities of Mayfly Nymphs of the Genus *Hexagenia.* (By title.) F. EARLE LYMAN, Tennessee Valley Authority, Norris, Tennessee.
24. An Unorthodox Spermatheca and Two Pairs of Colleterial Glands in Lepidoptera. (By title.) JOSEPH L. WILLIAMS, Lincoln University, Pennsylvania.
25. The Oviposition of Certain Captive Mosquitoes in Inorganic Solutions. (By title.) KENNETH B. M. CROOKS, Happy Grove College, Hectors River, Jamaica, B. W. I.

The following is a report of the Annual Business Meeting which was held Wednesday afternoon, December 31, following the paper reading session:

REPORT OF THE SECRETARY

During the year 1941, the following, having been duly nominated and recommended, were elected members of the Society by mail ballot of the Executive Committee:

ALFRED A. BERTAGNOLLI, Division of Entomology, University Farm, St. Paul, Minnesota.
A. M. CHICKERING, 206 South Mingo St., Albion, Michigan.
LORIN R. GILLOGLY, R. F. D. No. 1, Box 1160, Vista, California.
DILWORTH D. JENSEN, 1583 D St., San Bernardino, California.
JOSEPH W. JONES, JR., 620 17th St., Knoxville, Tennessee.
LOUIS C. KUITERT, Department of Entomology, University of Kansas, Lawrence, Kansas.
GILBERT WRIGHT, Illinois State Museum, Springfield, Illinois.

With the approval of the Executive Committee a joint symposium on the subject "The Relation of Taxonomy to Economic Entomology" was arranged with the American Association of Economic Entomologists.

With the approval of the Executive Committee a joint meeting with the Teaching Section of the American Association of Economic Entomologists was arranged.

DR. G. F. MACLEOD kindly consented to act as chairman of the local committee on arrangements at San Francisco to represent our Society and the American Association of Economic Entomologists and was so appointed by PRESIDENT HERMS. Other members of the local committee were H. M. ARMITAGE, FRANK A. BROWN, E. T. DOYLE, E. O. ESSIG, J. E. ECKERT, S. B. FREEBORN, A. J. FLEBUT, L. R. GARDNER, W. B. HERMS, E. G. LINSLEY, GORDON LAING, ED. LITTOOY, A. E. MICHELBACHER, HENRY SCHACHT and R. N. WILSON.

With the approval of the Executive Committee PROFESSOR G. F. FERRIS, Leland Stanford University, was invited to give the Annual Public Address at the San Francisco meeting.

PRESIDENT HERMS appointed DR. FRANK E. LUTZ to serve as official delegate of the Society at the Centenary celebration of Fordham University, New York City, September 15–17, 1941.

President Herms appointed Dr. P. P. Calvert to serve as official delegate of the Society at the one hundred and seventy-fifth anniversary of Rutgers University, New Brunswick, New Jersey, October 10–11, 1941.

The Executive Committee, voting by mail, unanimously approved the request of the Thomas Say Foundation Committee for a loan from the Permanent Fund of the Society to finance the publication of a fourth volume of the Thomas Say Foundation Series.

The Executive Committee met at 7:30 P. M., December 30, 1941, at the St. Francis Hotel, San Francisco, California, the following officers being present: W. B. Herms and Clarence E. Mickel. One other member of the committee was present: C. F. W. Muesebeck. The following alternates designated by the President, served in place of the absent members of the committee: E. O. Essig, G. F. Ferris and S. E. Flanders.

The following were elected to membership in the Society:

Paul H. Barrett, Hunt Creek Experiment Station, Lewiston, Michigan.
Ivan C. Brooks, Dept. of Entomology, Purdue University, Lafayette, Indiana.
Roy W. Chamberlain, Dept. of Entomology, Montana State College, Bozeman, Montana.
E. H. Coe, c/o L. H. Butcher Co., 2030 Bax St., Los Angeles, California.
Margaret L. Cook, 114½ N. Hamilton Drive, Beverly Hills, California.
Carl K. Dorsey, Box 639, Gulfport, Mississippi.
Florence M. Frost, 112 Agricultural Hall, University of California, Berkeley, California.
Edson J. Hambleton, Estacion Experimental Agricola, Casilla 37, Canete, Peru.
Brother Cyprian James, Manhattan College, Spuyten Duyvil Parkway, New York, N. Y.
Carl G. Kadner, Dept. Biology, Loyola University, Los Angeles, California.
Sol Kriminetsky, Fernald Hall, Massachusetts State College, Amherst, Massachusetts.
Ellis C. Kent, Avondale Apts. No. 21, Jackson and Kings Road, Corvallis, Oregon.
Darrell R. Maddock, Dept. Entomology, Utah State College, Logan, Utah.
Fred R. Platt, 218 W. Center St., Covina, California.
Don Pletsch, Dept. of Entomology, Montana State College, Bozeman, Montana.
Morris Rockstein, Division of Entomology, University Farm, St. Paul, Minnesota.
Wm. M. Rogoff, Dept. of Entomology, Cornell University, Ithaca, New York.
Reece I. Sailer, 316 Snow Hall, University of Kansas, Lawrence, Kansas.
Jack W. Sears, Dept. of Zoology, Texas University, Austin, Texas.
Gordon F. Smith, Division of Entomology and Parasitology, University of California, Berkeley, California.
William R. West, Box 142, State College, Mississippi.
Michael A. Weymarn, 2086 O'Farrell St., San Francisco, California.
Willis W. Wirth, Biology Dept., Louisiana Polytechnic Institute, Ruston, Louisiana.
Elwood C. Zimmerman, Bishop Museum, Honolulu, T. H.

The following have resigned during the year: Paul B. Allen, Jr., Mary Auten, P. P. Babiy, Judson J. Beougher, Leslie Bergren, A. W. A. Brown, George F. Carter, W. H. Clarke, Merrill M. Darley, John D. Detwiler, Heber C. Donohoe, J. K. Holloway, George R. Hopping, Priscilla B. Hussey, Satoru Kuwayama, Ralph H. Lewis, A. H. MacAndrews, Virgil I. Miles, David F. Miller, Geo. E. Nettleton, 2nd, Eugene F. Powell, W. E. Shull, Leslie M. Smith, J. C. Swartzwelder, Geo. A. Thompson, Jr., R. du Toit, B. H. Wilford, Grace O. Wiley and Inez W. Williams.

The following have been automatically dropped from membership either because of failure for three or more years to pay dues or because they cannot be reached: James B. Gross, May Katharyn Gyger, Syuchi Issiki, John C. Pallister, H. E. Parish, E. Graywood Smyth, A. L. Strand, H. D. Thomas and W. C. Woods.

The Executive Committee elected the following Fellows: A. J. BASINGER, E. W. BERGER, S. W. BILSING, G. H. BRADLEY, ROY E. CAMPBELL, O. L. CARTWRIGHT, CARL D. DUNCAN, R. W. GLASER, GRACE H. GRISWOLD, T. L. GUYTON, GILBERT J. HAEUSSLER, DAVID G. HALL, F. H. LATHROP, E. GORTON LINSLEY, PHILIP LUGINBILL, A. E. MICHELBACHER, ANTHONY MUSGRAVE, H. H. RICHARDSON, C. W. SABROSKY, GEO. D. SHAFER, M. A. STEWART, ROBERT L. USINGER, G. STUART WALLEY, LEWIS H. WELD and JOSEPH WILCOX.

The Executive Committee unanimously nominated the following for Honorary Fellowship at their meeting in Philadelphia, 1940: ADAM G. BOVING and C. L. MARLATT. The election by ballot was held in the fall of 1941, each member of the Society receiving a ballot by mail with the request that it be returned immediately. Three hundred and twenty-eight ballots have been returned to the SECRETARY. Both were elected.

The Society has suffered the loss by death of the following fourteen members and former members during the past year: GEORGE R. ELSTER, GEORGE A. FICHT, C. P. GILLETTE, A. A. GIRAULT, SAMUEL HENSHAW, CHARLES H. HICKS, RALPH HOPPING, HUGO KAHL, JAMES A. NELSON, LEE A. STRONG, JOHN N. SUMMERS, MYRON H. SWENK, JAMES TROOP and WARREN J. WILLIS.

GEORGE RUDOLPH ELSTER, a member of our society since 1936, was born at Jewell, North Dakota, in 1897, and died at St. Paul, Minnesota, December 31, 1940. His boyhood was spent at Enderlin and Lucca, North Dakota. Later he attended Concordia Academy and Concordia College at Moorhead, Minnesota, and graduated from the college in 1920. He was biology instructor at Eureka Lutheran College at Eureka, North Dakota, until the school closed. He then became biology instructor and athletic coach at the former Luther College in St. Paul, Minnesota. He took his Master's Degree with a major in botany and a minor in entomology at the University of Minnesota. He was instructor of biology at Eveleth Junior College, Eveleth, Minnesota, from the fall of 1939 until his death. He was married in 1922 to Marie Alward, of Mankato, Minnesota, who survives him.

GEORGE AUGUSTUS FICHT, a member of our society since 1927, was born at Vandecar, Ontario, Canada, November 27, 1900, and died at Auburn, Indiana July 29, 1941, following a short illness. He spent his early years on the farm. After graduating from high school he attended Ontario Agricultural College where he obtained the degree of Bachelor of Scientific Agriculture in June, 1923. Three years later, June, 1926, he obtained the degree of Master of Arts from the University of Western Ontario. In September, 1926, FICHT registered in Iowa State College for further graduate work. Previous to this time he had been associated with the Canadian Entomological Service for two and one-half years in corn borer research. In March, 1927, FICHT accepted an appointment with the Department of Entomology of the Purdue University Agricultural Experiment Station. At the time of his death he held the position of Associate in Entomology in charge of the European Corn Borer Research Laboratory. As a student, GEORGE FICHT showed a native ability to master scientific principles and technical problems. He was selected for membership in Sigma Xi and Phi Kappa Phi. He was also a member of the American Association for the Advancement of Science, American Association of Economic Entomologists and the Indiana Academy of Science. FICHT conducted research on a variety of crop pests, including gladiolus thrips, cutworms, and tomato nematodes, but by far his major contributions were those pertaining to the European corn borer. His detailed studies on the life history and habits of the corn borer, effect of date and rate of planting corn, relation of sanitary and cultural practices, such as plowing, ensiling and shredding to corn borer abundance, hybrid corn resistance and tolerance, and attractiveness of types of lights to the corn borer moths, are the bases of preventive and control recommendations for the European corn borer in Indiana. It was our privilege to be closely associated with GEORGE FICHT for many years. He was likable, generous, a hard worker, thorough, and always careful in the planning and execution of his research investigations. Not only was he careful in planning and executing his research, but also capable in interpreting the results. GEORGE FICHT lived a short life, but during those few years he achieved much. He was the author of many technical and popular papers which are valuable contributions to the science of Entomology and the results of his life work will have a

permanent value to American Agriculture. We who knew him intimately will remember him as a true friend and an ingenious technician, as well as a benefactor of mankind. He is survived by his wife, Annie Hilda Ficht, and his father.
—J. J. DAVIS.

CLARENCE PRESTON GILLETTE, a Charter Member of our Society, a fellow since 1907 and an Honorary Fellow since 1937, was born April 7, 1859, at Maple Corners, Ionia County, Michigan, the son of William Henry and Larissa Preston Gillette, and died at his home in Fort Collins, Colorado, January 4, 1941. His elementary education was received in the rural schools of Michigan where he later taught for a time. In 1886 he received the degree of Bachelor of Science from Michigan State College and in 1887 the degree of Master of Science. The same institution conferred the honorary degree of Doctor of Science upon him in 1916. One year of graduate study was done at the University of Illinois under Dr. S. A. Forbes. In 1888 after serving for a time as assistant in the Department of Zoology, Michigan State College, he was made entomologist of the Iowa State College Agricultural Experiment Station, Ames, Iowa, which position he held until 1891 when he was called to take charge of a new department of Zoology, Entomology and Physiology in the Colorado Agricultural College, now the Colorado State College of Agriculture and Mechanical Arts. In 1907 Dr. Gillette became Colorado's first State Entomologist. He filled this position for twenty-four years in addition to his college duties and the work which came, July 1, 1910, when he was made Director of the Colorado Agricultural Experiment Station. He became Director Emeritus of the Colorado Experiment Station and Professor Emeritus of Entomology and Zoology Sept. 1, 1932. During the last several years of his active service he was Vice-President of Colorado State College. In spite of his many administrative duties he has a long list of titles to his credit in the taxonomic and economic fields. His principal work in taxonomy was with the Cynipidae, Cicadellidae and Aphidae. Many new species in those groups were described by him. As State Entomologist he created one of the first county systems for handling control and regulatory work. He was eminently successful as an experiment station director, instilling in all workers the confidence, loyalty and peace of mind so essential in scientific research. He loved teaching and was an outstanding teacher as attested by the success of his students and their very high regard for him. He was very generous of his time and energy in helping students in their work and with their personal problems.

Dr. Gillette took an active part in community and church affairs. He was a member of several civic organizations, twice president of the County Red Cross and was always willing to lend assistance to any move for community betterment. A Sunday School class which he taught for many years was always well attended and was known for its open and free discussion. He was a member of the Board of Trustees of the First Presbyterian Church of Fort Collins for almost fifty years.

Dr. Gillette was a fellow of the American Association for the Advancement of Science, a Charter Member of the American Association of Economic Entomologists and its President in 1901, Honorary Member of the Iowa Academy of Sciences, member of the Colorado-Wyoming Academy of Sciences, the American Genetic Association, and the American Eugenics Society. He was Chairman of the Rocky Mountain Conference of Entomologists from its organization in 1923 until 1939, when he was made Honorary Chairman. He was a member of the honorary societies of Sigma Xi, Phi Kappa Phi, and Alpha Zeta. March 31, 1886, he married Clara Smith, who died in 1925. Two daughters, Mrs. Florence Malcouronne and Miss Esther Gillette, and two grandchildren, and one great grandchild survive.—G. M. LIST.

ALEXANDRE ARSENE GIRAULT, a Charter Member of our Society, was born in Annapolis, Maryland, January 9, 1884, and died in Brisbane, Queensland, Australia, May 2, 1941. He received the Bachelor of Science degree from the Virginia Polytechnic Institute in 1903 and the following year began his professional entomological career as a field assistant in the Bureau of Entomology. In 1908 he accepted an assistantship in the laboratory of the State Entomologist of Illinois and from 1909 to 1911 he was assistant in entomology at the University of Illinois. He went to Queensland, Australia, in 1911 to become entomologist of the Bureau of Sugar Experiment Stations, remaining in this position until 1914 when he returned to the United States to re-enter the service of the federal Bureau of Entomology as expert on the classification of chalcid flies. For three years he remained in Washington in that capacity, having an office at the National Museum. In 1917 he again went to Australia, this time as assistant entomologist of the Queensland Department of Agriculture. Although employed only intermittently during recent years, he remained in Australia and continued his studies in the field of insect taxonomy until the time of his death. Mr. Girault's principal interest was the description and classification of chalcid flies. He described approximately 750 new genera and many more new species, mostly from Australia, and occasionally he also described new species of Australian thrips. His publications number approximately 325 titles, and include a large work entitled "Australian Hymenoptera Chalcidoidea" which comprises more than 900 pages of volumes 1 to 4, inclusive, of the *Memoirs of the Queensland Museum*, published 1912–1915. Most of his papers, however, are very short, containing merely brief notes and descriptions of new genera and species; and some of them were badly printed on a small press of his own. These privately printed papers were distributed to comparatively few institutions and workers and, therefore, have not been readily available to all students of the chalcid flies. Brilliant, industrious and a keen observer, Girault might have contributed vastly more than he did to sound progress in the study of the Chalcidoidea. Unfortunately, he was erratic and not suited temperamentally for participation in undertakings that require co-operative effort. He worked alone, largely ignoring other investigators in the same field and apparently unmindful of difficulties he might be creating for future workers. This was, indeed, carried to the point of irreparably damaging type specimens of many species of chalcid flies in efforts to see certain specific structures to which he happened at the moment to attach special importance. Furthermore, his descriptions are mostly inadequate for the recognition of the genera or species to which they apply. Undoubtedly, however, these shortcomings are in large measure ascribable to continuing ill health, and it must be acknowledged that in spite of them GIRAULT added appreciably to our knowledge of a large and exceedingly complex group of Hymenoptera.—C. F. W. MUESEBECK.

SAMUEL HENSHAW, a Charter Member of our Society, and a Fellow since 1907, was born on January 29, 1852, in Boston and died at the ripe age of 88 in Cambridge, Mass., on February 5, 1941. He never attended any college, but received the honorary degree of Master of Arts in 1903 from Harvard University, and in 1926 was elected an Honorary Member of the Phi Beta Kappa Society. His connection with Harvard began in 1891, when he acted as assistant in entomology. He retired in 1927 as Director of the Museum of Comparative Zoology, a position which he had held for sixteen years. Prior to his appointment as Director he had served successively as Librarian and Curator of the museum. Henshaw's active interest in insects appears to have begun at the Boston Society of Natural History in 1876 when he had reached the age of 24. There, as assistant to Alpheus Hyatt, he naturally developed a familiarity with other types of animals, but insects still remained his first love in later years. In 1892, he was appointed Librarian and Secretary for the Boston Society of Natural History, retaining this position for a decade, during which his time was divided between the Boston Society and the Harvard Museum. Every working entomologist during the latter part of the last century and early years of the present one was familiar with Henshaw's "List of the Coleoptera of America North of Mexico," first published in 1885. This, together with Leconte and Horn's "Coleoptera," encouraged many a young collector of insects to undertake his first serious entomological work and without doubt the number of active coleopterists during this period was greatly augmented by the availability of Henshaw's list. The writer of this notice was one such individual who so worshipped these two "Bibles" that he has never forgotten the delight of a neatly arranged collection of beetles, named and numbered according to Henshaw's list and the several supplements thereto. The latter followed in 1889 and 1895. The last, or third supplement, became far too voluminous to suit its compiler, as Henshaw heartily disapproved of the taxonomic "splitters" as exemplified by Colonel Casey who was particularly active at that time in increasing the North American beetle fauna. Consequently, no further supplement appeared and twenty-five years elapsed before the appearance of Leng's catalogue in 1920.

Mr. Henshaw was an indefatigable worker and the collections, entomological and otherwise in the Museum of Comparative Zoology bear innumerable evidences of the never-ending attention which he gave them. Enormous numbers of labels in the insect collections are in his handwriting which was a bold flowing script of very characteristic form, but never scrawled nor illegible like that of most persons who do a vast amount of writing. The Museum library also shows his zeal in listing accessions, checking the receipt of journals and numerous other details that were meticulously cared for. The Museum of Comparative Zoology and its library have grown enormously since then, but even during Henshaw's time it was utterly impossible for him to keep up with the endless tasks that he imposed upon himself and consistently hesitated to delegate to others. This trait was undoubtedly due in great part to his solicitude for the collections under his care for which he attempted to assume complete personal responsibility. The same attitude was apparent in other ways. The various rooms of the museum required many separate keys and Henshaw had a long chain to which these were attached in seemingly endless variety. This chain he carried about with him, selecting one key or another as he personally admitted visiting scientists to study the collections or went about his daily routine through the several sections of the museum.

For fifteen years he edited and published privately the entomological journal "Psyche" and also edited the publications of the Museum of Comparative Zoology during the years that he was Curator and later Director of the Museum. In his editorial work he examined all manuscripts with an eagle eye and was never bashful in pointing out any careless or inaccurate citations to those who submitted them. As he had wide experience in bibliographic work his apparently caustic remarks usually made a lasting impression, greatly to the benefit of zoological literature in general. His most extensive bibliographic contribution was a work on "The More Important Contributions to American Economic Entomology," which marked the beginning of an extensive project that has been since continued under the auspices of the Federal Bureau of Entomology and the American Association of Economic Entomologists. In his younger days he was one of the small group, including S. H. Scudder, J. H. Emerton, Edward Burgess, A. S. Packard, E. A. Schwarz and H. A. Hagen, who organized the Cambridge Entomological Club in 1874. In his later years at least, he rarely attended meetings of the Club, or other scientific gatherings, but many evenings were spent in the museum where he continued the day's work in solitude and far into the night. HENSHAW'S publications were not numerous, but his influence on the development of taxonomic entomology in America was an important contribution fully appreciated by contemporary workers. He was a man of small stature, but of endless energy. His disposition was genial when among those of whom he was fond or with those whom he felt would further the purpose of the museum or take full advantage of the facilities offered by it. In other words, the museum seemed always to occupy the first place in his mind. In the presence of others his manner was sometimes apparently gruff or even uncompromising, due apparently to his manifold duties that cried out against interruption. There were many who came to study the vast collections and type specimens conserved in the museum and in this way HENSHAW came into personal contact with a very large number of working entomologists as well as students of other branches of natural history.—CHARLES T. BRUES.

CHARLES HENRY HICKS, a member of our Society from 1930 to 1938, died at Burbank, California, on September 6, 1941. He received his B.A. degree from the University of Wisconsin in 1924 and his Ph.D. degree from the University of Colorado in 1933. During his teaching career he taught entomology and biology at the University of Wisconsin, Pasadena Junior College, the University of California at Los Angeles and the University of Colorado. While he was a naturalist first, in more recent years he devoted his time to writing and editing. As an author he contributed many original poems to outstanding anthology and poetry magazines. He is survived by his wife, one daughter, his sister and his mother.

RALPH HOPPING, a member of our Society since 1927, was born April 8, 1868, in New York City and died October 29, 1941, in Vernon, British Columbia. He was the son of George W. Hopping, an expert accountant, and Laura DeGrasse Hopping. He moved to California in 1888 and joined the Cooperative Kaweah Colony in Tulare county, and in 1889 married Katherine Blanche Redstone. When the Kaweah Colony disintegrated he entered a partnership in the tourist business with headquarters in Grant Forest Sequoia National Park. Here he formed many lifelong friendships and met many notable persons. Theodore Roosevelt personally engaged him to conduct a trip by pack train from Lone Pine on the east slope of the Sierra Nevadas to the San Joaquin valley, but the trip was cancelled at the last moment due to the assassination of President McKinley. When his tourist business was terminated in 1905 he entered the United States Forest Service and in 1912 his ability as an entomologist was recognized by his appointment as Forest Entomologist with headquarters at San Francisco. He served seven years in this capacity carrying on work in California, Oregon, New Mexico, Arizona and Colorado. He was appointed Entomologist in Charge of the Vernon, British Columbia, Insect Laboratory in 1919 and held that position for twenty years. He retired on April 8, 1939, with the rank of Senior Agricultural Scientist. He sustained a deep loss in September, 1929, at the death of his wife. He is survived by Mrs. Eltha Edwards Hopping, whom he married May 12, 1939, two daughters, Mrs. Parker Talbot of San Luis Obispo, California, and Mrs. H. C. Hughes of Nelson, British Columbia, and a son, George R. Hopping, Entomologist in Charge of the Vernon, British Columbia, laboratory.

PAUL HUGO ISIDOR KAHL, a member of our Society since 1916, was born March 17, 1859, in Visby, on the Island of Gottland, Sweden, where his father was a clergyman of the State Church, and died at Pittsburgh, Pennsylvania, February 19, 1941. He received a thorough education in general and classical sciences, and graduated with highest honors at the College of Visby. Upon his arrival in America in 1892 he took courses at the University of Kansas in natural history, specializing in entomology and becoming well versed also in other branches of zoology and botany. He was appointed assistant entomologist and ornithologist at the State Laboratory of Natural History of Illinois and during the World's Columbian Exposition in 1893 was given charge of the Illinois exhibits in natural history. DR. KAHL was connected with the faculty of the University of Kansas from 1894 to 1901 as Systematic Entomologist and Curator of the Entomological Museum. In 1901 he became again associated with the Illinois State Laboratory of Natural History as Systematic Entomologist and Curator of the Entomological Collections, serving at the same time as Inspector of Nurseries and Orchards for the extermination of insects injurious to vegetation. In 1902 he was appointed Custodian of the Section of Entomology at the Carnegie Museum, Pittsburgh, following the invitation of the Director, Dr. W. J. Holland, one of the most distinguished entomologists of his time. In 1923 DR. KAHL became Curator of Entomology, which position he held until January 1, 1941, when he was appointed Curator Emeritus. He was awarded an Honorary Doctorate in Science at the University of Pittsburgh in 1927, and was a member of the faculty of the University as Advisory Professor of Biology. DR. KAHL was a member of the American Association for the Advancement of Science, the American Ecological Society, an Honorary Member of Sigma Xi, and a member of Phi Kappa Psi. DR. KAHL enjoyed a well deserved reputation of one of the outstanding authorities on Diptera and Odonata. He possessed an exceptionally wide knowledge of all the diverse branches of entomology, an uncommon erudition on systematics, biology, ecology, and was noted for his masterly command of entomological bibliography. He was responsible for the arrangement and supervision of the entomological collections of the Carnegie Museum which are renowned for their richness. Outside of the scientific field to which DR. KAHL gave his special attention, he never neglected the various angles of cultural life of his community. He was Chairman of the Committee for the Swedish National Room of the University of Pittsburgh, and was responsible for organizing the efforts of his countrymen during the creation of a suitable memorial reflecting the traditions of the land of his birth. He was actively assisted in this cause by his able wife, who presided over the Swedish Women's Committee. In 1940 the King of Sweden conferred upon Dr. Kahl the Knighthood of the First Class of the Royal Order of Vasa in recognition of his valuable services rendered in connection with cultural relations with Sweden. He was a citizen of the United States, having become an adopted son of this country shortly after his arrival in America so that he might stay permanently in the New World. DR. KAHL endeared himself to a host of friends in his community. He was revered and beloved for his invariable graciousness, kindly disposition, and his willingness to be of every help at his command. A long and useful life serenely and actively spent among the things he loved came to a peaceful close.—A. AVINOFF.

JAMES ALLEN NELSON, a member of our Society since 1907 and a Fellow since 1940, was born at Urbana, Ohio, April 29, 1875, and died at Gambier, Ohio, August 9, 1941. He was graduated from Kenyon College with the degree of Ph.B. in 1898 and received the Ph.D. degree from the University of Pennsylvania in 1903. His doctor's thesis was a cell lineage study of the early development of a species of *Dinophilus*, to which he later gave the specific name *Conklini*, a member of a primitive group of animals which have been variously placed among rotifers, annelids and tubellaria. Later he also studied the adult structure of this species and from both pieces of work concluded that the genus has close affiliations with the chaetopod annelids. His graduate work did not include enough on insects and spiders to meet his desires, and in 1904 he accepted an honorary fellowship at Cornell University where he remained for four years. He worked under Professor Comstock and made contributions on the palpi of spiders. Because of the high skill which he had shown in microscopic work in the field of embryology, and also because of the newer interests which he had acquired in insects, he was appointed to the Bureau of Entomology in 1908. Here he prepared his noted book on the embryology of the honeybee and later published papers on the larval structure and abdominal segmentation of this species. With Sturtevant and others he published observations on honeybee growth. As one who worked with him, acknowledgment should also be made of his keen interest in anything which would add to the facilities and effectiveness of the office with which he was associated. He resigned his position in 1918 because of ill health and was not again able to undertake a regular activity. His keen interest in gardening and his skill on the piano provided him with abounding interests for the remainder of his life. He finally settled in his old college town, Gambier, where he took much interest in the affairs of students, of members of the faculty and of his fellow citizens of the community. NELSON was a member of the American Society of Zoologists, the American Association of Economic Entomologists and of the Ohio Academy of Sciences. He is survived by his wife and one daughter.

—E. F. PHILLIPS.

LEE A STRONG, a member of our Society since 1931, was born at Russell, Iowa, in 1886, the son of Hez G. and Julia B. (Ashby) Strong, and died at Madera Canyon, near Tucson, Arizona, June 2, 1941. He received his only formal education in the public schools of Nehawka, Nebraska. DR. STRONG's career in plant quarantine and inspection work began in California in August, 1910. From that date he occupied the positions of horticultural inspector, deputy quarantine officer, chief deputy quarantine officer and chief of the Bureau of Plant Quarantine for the California Department of Agriculture until in 1925 he was appointed Assistant Director of Agriculture for the State of California. His service with the California Agriculture Department was interrupted twice: first, in March, 1918, when he resigned to join the army and served with the 537th Engineers until July, 1919, twelve months of which time were spent in France with the American Expeditionary Force. The second lapse in his work with the California Department occurred in 1923 when he was appointed as Specialist in Plant Quarantine with the Federal Horticultural Board of the United States Department of Agriculture, which position he left in 1925 to return to California as Assistant Director of Agriculture for that State. In December, 1929, DR. STRONG began his permanent connection with the United States Department of Agriculture when he was appointed Chief of the Plant Quarantine and Control Administration, later known as the Bureau of Plant Quarantine. In 1933, on the retirement of Dr. C. L. Marlatt as Chief of the Bureau of Entomology, he became chief of that Bureau; and in 1934 was made Chief of the newly consolidated Bureau of Entomology and Plant Quarantine, which position he held until the time of his death.

DR. STRONG was one of the organizers of the Western Plant Board and served as Secretary of the Board for several years. The usefulness of the Western Plant Board led to the organization of similar regional boards—Central Plant Board, Southern Plant Board and Eastern Plant Board; and the work of the regional boards was finally co-ordinated in the organization of the National Plant Board. He took a prominent part in the preliminary work incident to this organization and was Chairman of the National Plant Board from 1923 to 1929. In 1935, 1937 and 1938 DR. STRONG took part in conferences held in Mexico with agricultural officials of that country. These conferences resulted in better understanding and closer co-operation in pest control problems common to both countries. In 1938 he served as Chairman of a Commission of Technical Experts appointed by the Secretary of Agriculture to confer at the Hague with a similar commission of the Netherlands Government under the provisions of Article X of the Trade Agreement between the United States and the Netherlands. While on this trip conferences pertaining to entomological and plant quarantine problems were held in England, France, Belgium and Switzerland. DR. STRONG was a member of the American Association of Economic Entomologists, serving as its president in 1935. He was also a member of the Entomological Society of Washington. In 1938 he received the honorary degree of Doctor of Science from Louisiana State University. DR. STRONG'S knowledge of insects, the harm they do and the means for combating them was all self-acquired. He had the reputation of being a strong administrator, of being a man to get results rapidly, and throughout his work he showed a soundness of judgment and leadership which led to his recognition as a national authority in matters pertaining to economic entomology and plant pathology. DR. STRONG is survived by his widow, Edith M. (Colton) Strong, whom he married in 1921, three children—Madeline Virginia, Lee A., Jr., and Helen Tesora—three sisters and four brothers. Burial with military honors took place in Arlington National Cemetery.

JOHN NICHOLAS SUMMERS, a member of our Society since 1908, was born at Brockton, Massachusetts, January 25, 1884, and died suddenly of an acute heart attack at Greenfield, Massachusetts, October 18, 1941. He attended the Brockton public schools and high schools, and graduated from the Massachusetts State College in 1907 with the degree of Bachelor of Science, majoring in Entomology. He also received a similar degree from Boston University. He continued postgraduate work in Entomology at the Massachusetts State College and received the Ph. D. degree in 1911. June 16, 1911, he was appointed Scientific Assistant in the Bureau of Entomology and later was promoted to Entomologist. In 1914 he spent several months in Europe collecting and shipping parasites of the gypsy moth to this country and collected data relative to gypsy moth infestations in many countries in eastern Europe which was of great value to the gypsy moth project in this country. He was a Second Lieutenant in the United States Army Tank Corps during the World War and was in the service from May, 1918, to August, 1919, most of the time being spent in France. He continued work on the gypsy moth project at the conclusion of the World War. In 1922 he spent six months in Japan and a similar period in 1923 collecting and shipping parasites of the gypsy moth to the United States. In 1927 he had charge of the quarantine and inspection work of the gypsy moth project for the Plant Quarantine and Control Administration and continued on that work until 1934. Since then he has carried on field and office work on gypsy and brown tail moths control and extermination work in the New England States. At the time of his death he was Administrative Officer, Division of Gypsy and Brown Tail Moths Control of the Bureau of Entomology and Plant Quarantine. He was a well trained and capable entomologist and on account of his varied experience in different types of entomological activities he had a large store of valuable information which was extremely useful in carrying on work on the gypsy moth. He prepared a number of reports and articles and had devoted some time to lecturing on insects and their economic importance. He was an active member of the American Association of Economic Entomologists, of the American Legion and other civic organizations and was highly respected by all who knew him. He is survived by his wife and a son, John N. Summers, Jr.

—A. F. BURGESS.

MYRON HARMON SWENK, a member of our Society from 1907 until 1921, died at his home in Lincoln, Nebraska, on July 7, 1941. PROFESSOR SWENK became a member of the faculty of the University of Nebraska in 1907, on the staff of the Department of Entomology. He was appointed Chairman of the Department in 1922, a position which he retained until the time of his death. Throughout the course of his professional career he was actively engaged in both teaching and research and contributed a large number of publications on various phases of entomology, particularly in the fields of economic entomology and taxonomy. In addition he published numerous articles in the field of ornithology and mammology. His wife survives him.

JAMES TROOP, a member of our Society from 1907 to 1924, was born March 14, 1853, at Bennington, New York, and died at Urbana, Illinois, October 14, 1941, just three months after the death of his wife at Lafayette, Indiana, his home for 57 years. PROFESSOR TROOP was graduated from Michigan Agricultural College in 1878 where he was an associate of such notable scientists as Clarence P. Gillette and Liberty Hyde Bailey. The next year he spent in doing postgraduate work at Cornell University and the winter following in study at Harvard. In 1880 he returned to Michigan Agricultural College to become a member of the Horticultural Staff, and received his Master of Science degree there in 1882. PROFESSOR TROOP went to Purdue University in the fall of 1884, retaining his connection with this institution to the day of his death. During his first years at Purdue as Head of the Department of Horticulture and Entomology, there was only one other teacher on the Agricultural faculty. In addition to Entomology and Horticulture, he taught Forestry, Botany and Veterinary Science. After 28 years as Head of Horticulture and Entomology the combined department was divided and he took over the headship of the Entomology Department, which he held until 1920 when he became Professor Emeritus. From 1899 to 1907 he was State Entomologist of Indiana, in which position he had charge of regulatory work including nursery inspection. From 1896 to 1901 he was secretary of the Indiana Horticultural Society, of which he was president in 1933. Because PROFESSOR TROOP was a pioneer in the field of Horticulture and to a large degree responsible for the development of this industry in Indiana, he was affectionately known as the "Grand Old Man of Indiana Horticulture." Many of the achievements in this field in Indiana may be attributed to his far-sightedness and pioneer work. As a teacher he was outstanding as evidenced by the facts remembered and fond recollections expressed by his many former students. Aside from his official duties with Purdue University, PROFESSOR TROOP was active for many years in University and community affairs. He was a Charter Member of the Purdue Chapters of Alpha Zeta and Acacia fraternities. He was past commander of the Lafayette Commandery of Knights Templars, of which he was also Prelate for 33 years. He was active in church circles, being Superintendent of the Baptist Church Sunday School and Deacon of the same church for many years. He is survived by a daughter Helen, wife of Professor O. H. Sears of the University of Illinois, and two grandchildren Marjorie and Gordon Sears.—J. J. DAVIS.

WARREN JENNISON WILLIS, a member of our Society since 1923, died in New York City on April 16, 1941. He held the degrees of B. S., U. S. Naval Academy; M. S., George Washington University and J. F. D., New York University. At the time of his death he was employed by the Union Carbide and Carbon Research Laboratory. He is survived by his wife.

Following the reading of these brief memorials the members stood in silence in memory of the fourteen who have died during the past year.

The total membership on December 31, 1941, is 949.

The following were elected by the Executive Committee to the Editorial Board of the Annals for the term expiring December 31, 1944: C. P. ALEXANDER, PAUL S. WELCH and HARRY H. KNIGHT.

The following were elected by the Executive Committee to the Thomas Say Foundation Committee for the two year term ending December 31, 1943: A. C. KINSEY and E. O. ESSIG.

The Executive Committee voted to contribute $100.00 to the Royal Zoological Society of London for the support of the Zoological Record.

The Executive Committee recommended that the Joint Committee on Insect Collections be discontinued.

The Executive Committee considered three proposals regarding an Advisory Committee on Scientific Nomenclature and adopted the one submitted by the Pacific Coast Entomological Society which is as follows:

(1) That an American Commission on Scientific Nomenclature in Entomology be established.

(2) That this Commission be composed of individuals who are now, and may expect to be for some time to come, engaged actively in systematic work in Entomology and are especially concerned with and competent to consider the problems of nomenclature.

(3) That this Commission be composed of at least ten and not more than fifteen members who are as far as is practicable representative of the entomological organizations and entomologically active geographical areas of the United States and Canada.

(4) That in order to form this Commission the Entomological Society of America and the American Association of Economic Entomologists each appoint one member (preferably prior to the 1941 annual meetings,) these two to select

the remaining members of the Commission, the member representing the Entomological Society of America to act initially as chairman.

(5) That this Commission be instructed to study the present International Code of Zoological Nomenclature and the Report of the British National Committee on Entomological Nomenclature (1928).

(6) That this Commission be instructed to receive from entomologists and give consideration to suggestions for additions to the existing International Code of Zoological Nomenclature.

(7) That the Commission prepare a report to be submitted at the 1942 annual meeting of the national entomological societies, this report to present the basis for a Code of Entomological Nomenclature.

President W. B. Herms appointed Professor G. F. Ferris to act as Chairman of the Advisory Commission on Scientific Nomenclature in Entomology in conformity with Article 4 of the above proposal.

The Executive Committee voted to hold the 1942 Annual Meeting at New York, N. Y., at the same time as the meetings of the American Association for the Advancement of Science.

The Executive Committee adjourned at 10:45 P. M.

Respectfully submitted,
Clarence E. Mickel, *Secretary.*

On motion the Secretary's Report was accepted and the recommendations of the Executive Committee adopted.

REPORT OF THE TREASURER

Current Funds

RECEIPTS

Balance on hand in Bank, December 20, 1940 (See Annals, Vol. 34, p. 266)	$1,979.20
From Annual Dues of Members to December 10, 1941	3,536.26
From Clarence H. Kennedy, Managing Editor of Annals	500.00
From four Life Memberships, C. C. Deonier, A. B. Gurney, J. A. Munro and Donald G. Denning	200.00
From Sale of Five Membership Lists	5.00
Total	$6,220.46

EXPENDITURES

Postage, including 2,000 three-cent stamped envelopes and 1,000 one and one-half cent stamps	$ 85.52
Spahr and Glenn Printing Co., Columbus, Ohio, printing December, 1940, and March, June and September, 1941, Annals	4,394.36
Letterheads for President and Secretary-Treasurer, and stamped envelopes for President	16.75
Office Supplies	28.15
Printing Preliminary Announcements, Blank Forms and Programs	114.25
Clerical Services	36.00
Contribution to Royal Zoological Society of London for Zoological Record	50.25
Expense in connection with Philadelphia Meeting	8.75
Travel expenses of Secretary to Urbana, Illinois, Dedication of Natural History Survey Bldg., and to Philadelphia Meeting	137.15
Checks returned by Bank	8.30
Exchange on checks at Bank	30.98
Transfer of Life Membership Payments to Permanent Fund of C. C. Deonier, A. B. Gurney, J. A. Munro and Donald G. Denning	200.00
Total expenditures	$5,110.46
Balance in Checking Account, December 10, 1941	1,110.00
Total	$6,220.46

LIABILITIES

The Society owes the publishers for the December, 1941, Annals. Of the above cash receipts for dues, $1,368.00 is for 1942 and other dues paid in advance.

PERMANENT FUND

RECEIPTS

Balance in Savings Account, December 20, 1940	$3,539.98
Interest on Savings Account, December 20, 1940, to December 10, 1941	35.08
Interest on Liberty Bond 45554-D	1.44
From Four Life Memberships	200.00
Total	$3,776.50

EXPENDITURES

(None)

Balance in Savings Account, December 10, 1941	$3,776.50
One Liberty Bond, 45554-D	50.00
Balance in Permanent Fund	$3,826.50

RESOURCES

Liberty Bond 45554-D	$ 50.00
Balance in Savings Account	3,776.50
Balance in Checking Account	1,110.00
Total	$4,936.50

Respectfully submitted,

CLARENCE E. MICKEL, *Treasurer.*

On motion the Treasurer's Report was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE MANAGING EDITOR OF THE ANNALS

The Annals for 1941 will be 868 pages in length which is 88 pages larger than for 1940.

In March of 1940 there was no manuscript on hand for the June issue. Three or four large papers arrived and were accepted for publication on the assumption that the Annals would probably be otherwise short of manuscript. Shortly after the acceptance of this group of papers the usual number of small papers arrived. It has taken extra space in two issues and has delayed the publication of some short papers to take care of these longer papers accepted at that time. The volume for 1942 will have to be only half as large or perhaps even smaller than that for 1941. We have been fortunate in being able to publish four papers from the Gorgas Memorial Institute in Panama in which all expenses of publication were paid by that institution.

The receipts of this office were about $75.00 less this year than last. We expect an even greater drop in 1942. We have been notified by the Post Office to hold all subscriptions to the Axis countries which, except for Japan, is not a serious loss.

We can report that the quality of the articles presented continues at a high level. We have been doing everything we could to keep the illustrations of the Annals at as high a level as possible as we feel that these make for sales to librarians and agents of scientific institutions.

We are immediately facing more expense for paper which, because of priority orders, will not be pure white in the next issue. We are facing rising wages in the printing trade. Both of these items will tend to hold the Annals to smaller issues.

The financial summary follows:

RECEIPTS

Non-member subscriptions	$ 949.94
Back numbers and reprints	139.42
From authors for cuts	355.96
From zinc and copper in old cuts	14.16
Bank balance from 1940	59.72
Total	$1,519.20

EXPENDITURES

To engravers	$ 428.18
Office help	249.60
Postage	131.20
Services of Paul Schaefer	73.55
Miscellaneous	72.50
To Secretary-Treasurer	500.00
Bank Balance, December 15, 1941	46.17
Undeposited checks	18.00
Total	$1,519.20

Respectfully submitted,
CLARENCE H. KENNEDY, *Managing Editor.*

On motion the Report of the Managing Editor was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION

RECEIPTS

Balance on hand, December 20, 1941	$307.38
1941 Sales of Volume I—1 copy, $3.00	3.00
1941 Sales of Volume II—2 copies, $5.00	10.00
1941 Sales of Volume III—1 copy, $4.00	4.00
Interest on Savings Account, July 1, 1940–June 30, 1941	4.53
Total Receipts	$328.91

EXPENDITURES

Postage	$ 1.62
Total Expenditures	$ 1.62
Balance in Purdue State Bank, December 23, 1941	$327.29

In addition to sales recorded above, two copies of Volume I and one copy of Volume II have been ordered but payment (totaling $9.70) not yet received.

The Foundation has assets in the form of books (Volumes I, II and III) which normally bring in around $100.00 a year.

For some time it has seemed advisable to publish a fourth volume. Dr. DAVID G. HALL has submitted his manuscript on the Blowflies of North America and this has been accepted for publication by the Foundation Committee. Also, the Executive Committee of the Entomological Society of America, under authority granted at the last annual meeting of the Society, has approved a loan for the publication. Because of the importance of blowflies to veterinarians and medical doctors, as well as to entomologists, it is felt the volume will be timely and have a good sale.

We have discussed the question of publication at the present time because of war conditions with a number of entomologists and others and it was the opinion that we should proceed with the publication without delay.

The manuscript is in the process of slight revision, but will soon be submitted and will be published, unless something unforeseen prevents.

Respectfully submitted,
J. J. DAVIS, *Editor and Treasurer.*

On motion the Report of the Treasurer of the Thomas Say Foundation was accepted, subject to the approval of the Auditing Committee.

REPORT OF THE AUDITING COMMITTEE

We, the undersigned members of the Auditing Committee, beg to report that we have carefully examined the accounts of the Treasurer of the Society, the

Managing Editor of the Annals and the Treasurer of the Thomas Say Foundation for the year 1941, and have found them to be correct and properly balanced.

Respectfully submitted,
MYKOLA H. HAYDAK, *Chairman*,
RAYMOND C. OSBURN,
HOWARD O. DEAY.

On motion the report of the Auditing Committee was accepted.

REPORT OF THE REPRESENTATIVE TO THE COMMITTEE ON AGRICULTURE OF THE NATIONAL RESEARCH COUNCIL

The activities of your representative to the Division of Biology and Agriculture of the National Research Council may be summarized as follows:

1. Part of the Entomologists in the National Defense Program. It was pointed out that the entomologists, in addition to the work already done, might render special services (1) in connection with termite and powderpost beetle control in the building program for camps, warehouses, and other wooden structures; (2) camp and personal sanitation in connection with the identification and control of mosquitoes, gnats, flies, lice, fleas, bedbugs, etc.; (3) in the protection and preservation of clothing and bedding by the destruction of clothes moths, carpet beetles, etc., and by insect-proofing certain essential woolen materials and furs; (4) protection of foods and stored-products against insect attacks both in the Army and the Navy.
2. Additional support to museums for a more adequate group of entomological specialists to determine insects in connection with expanding practical entomological research work.
3. Provision for the manufacture of insect pins, glass microscopic slides and cover glasses in this country to supply the needs of scientific workers. A very lengthy correspondence, submitted with this report, has to do with all the various phases of the difficulties of economically producing these materials in the United States, and I feel that much good has been accomplished by the recommendations and the resulting survey. To date there has not been a serious shortage of any of these, although there has been a considerable rise in price of all.
4. Registration of entomologists along with other scientists of the country was early made by the National Research Council.
5. At the last meeting in May, 1941, it was decided to elect two entomologists, one to represent each of the two national entomological organizations. These two representatives are uniting in a single program for all entomologists of the country.
6. An effort to secure from the entomologists any suggestions which might be presented to the National Research Council for consideration.

Respectfully submitted,
E. O. ESSIG, *Representative.*

On motion this Report was approved and placed on file.

REPORT OF THE COMMITTEE ON THE PROMOTION OF OFFICIAL ENTOMOLOGY

The business of this committee is to keep a constant watch on the field of official entomology for the purpose of anticipating the needs and taking advantage of the opportunities for official entomology as the trends appear.

Of course, this committee has promoted in every way that it could the granting of needed Federal appropriations, as well as of state and local.

Without any doubt whatever the greatest promotion of official entomology lies in educating the American people in the need for and the possibilities of insect control and extermination. Something more than newspaper or even magazine space is needed; something that will operate in educating the public year after year.

Your committee believes that a good, well-written book, setting forth the menacing problems of insect control and extermination as they exist in the United States, followed by a dramatic review of insect problems in the United States which have been solved, will do more to educate the public than anything else that can be done. Such a book would be a follow-up of the "Insect Menace."

Last year your committee made a distinct recommendation in this matter as follows: "Your committee, therefore, wishes to recommend that the two entomological societies endorse an effort of this kind and place this responsibility in the hands of an appropriate committee." So far as this year's chairman has been able to discover, the recommendation was not endorsed nor was any action taken looking toward its fulfillment. The committee wishes to repeat its recommendation of last year and to urge upon the two societies that something constructive along this line be arranged for.

Respectfully submitted,
T. J. Headlee, *Chairman.*
F. N. Wallace,
A. M. Boyce.

Since this report had not been submitted to the Society at the time of the Annual Business meeting, no action was taken.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Special joint resolution of the Entomological Society of America and the American Association of Economic Entomologists.

Whereas, During this National Emergency the profession of Entomology is conscious of the need for leadership and organization of effort, and

Whereas, the Bureau of Entomology and Plant Quarantine is in a unique position to furnish this leadership, and

Whereas, time is a vital element in the development of a national program,

Therefore, Be It Resolved, that the Chief of the Bureau of Entomology and Plant Quarantine be requested to call together at the earliest practicable moment a group of entomologists representative of the various entomological organizations, institutions and geographic areas of the United States for the purpose of ascertaining the best possible use of entomological personnel and facilities and for the development of a program for the most effective utilization of these resources, and that a copy of this resolution be sent to the Secretary of Agriculture and the Chief of the Bureau of Entomology and Plant Quarantine.

On motion the above resolution was adopted and the Secretary instructed to forward copies to the designated officials.

1. Whereas, the arrangements for the program, business meetings and entertainment for the 36th Annual Meeting of the Entomological Society of America have been so efficiently handled,

Therefore, Be It Resolved, That our Society extend its sincere appreciation to the local committee on arrangements composed of G. F. MacLeod, *General Chairman*, H. M. Armitage, Frank A. Brown, E. T. Doyle, E. O. Essig, J. E. Eckert, S. B. Freeborn, A. J. Flebut, L. R. Gardner, W. B. Herms, E. G. Linsley, Gordon Laing, Ed Littooy, A. E. Michelbacher, Henry Schacht and R. N. Wilson; to the San Francisco Convention and Tourist Bureau, to the California Academy of Sciences, to the University of California, and to the management of the St. Francis Hotel, where the meetings were held.

Be It also Resolved, That the Society express its thanks to Professor G. F. Ferris for his most interesting and scholarly public address.

2. Whereas, the usefulness and success of a scientific organization depend on the decisions and actions of its officers and since during the past year our Society has continued to maintain its high standard of service,

Therefore, Be It Resolved, That the Society extend its sincere thanks to W. B. Herms, *President;* Clarence E. Mickel, *Secretary-Treasurer;* and Clarence H. Kennedy, *Managing Editor* of the "Annals of the Entomological Society of America," and all other officers of the Society.

3. Whereas, the joint Symposium on the "Relation of Taxonomy to Economic Entomology," arranged by the Entomological Society of America and the American Association of Economic Entomologists, did much to improve the understanding of the mutual problems involved in these fields of endeavor,

Therefore, Be It Resolved, That the Society extend its thanks to those who participated in the 1941 symposium and that the officers for the coming year be instructed to make arrangements for a symposium for the 1942 meeting, dealing with some other broad phase of entomology.

4. WHEREAS, for the past two years the Taxonomists' Conference has been a most instructive and interesting addition to our program,

Therefore, Be It Resolved, That the Society extend its thanks to MR. C. F. W. MUESEBECK and to all other members whose active participation contributed to the success of this feature, and that the officers and program committee be instructed to arrange for a similar conference in 1942.

5. WHEREAS, the 1941 meeting was held on the Pacific Coast and the desirability of increasing membership in that area was evident,

Therefore, Be It Resolved, That the Society extend its thanks to DR. DON C. MOTE for his active efforts toward that end.

6. WHEREAS, during the past year our Society has suffered the loss of the following members and former members: GEORGE R. ELSTER, GEORGE A. FICHT, C. P. GILLETTE, A. A. GIRAULT, SAMUEL HENSHAW, CHARLES H. HICKS, RALPH HOPPING, HUGO KAHL, JAMES A. NELSON, LEE A. STRONG, JOHN N. SUMMERS, JAMES TROOP and WARREN J. WILLIS,

Therefore, Be It Resolved, The Society go on record as acknowledging our loss and instruct the Secretary to send a note of sympathy to the nearest surviving relatives.

Respectfully submitted,

L. HASEMAN, *Chairman*,
E. G. LINSLEY,
P. W. OMAN.

On motion the Report of the Resolutions Committee was adopted.

REPORT OF THE NOMINATING COMMITTEE

Your Committee places in nomination the following Fellows of the Entomological Society of America to fill the designated vacancies for the year 1942:

President—CHARLES P. ALEXANDER.
First Vice-President—MIRIAM A. PALMER.
Second Vice-President—WILLIAM T. DAVIS.
Secretary-Treasurer—CLARENCE E. MICKEL.
Two Members of the Executive Committee to Serve until 1944—M. H. HATCH and T. B. MITCHELL.
Councilors to the American Association for the Advancement of Science—J. F. YEAGER and CLAY LYLE.

Respectfully submitted,

E. O. ESSIG, *Chairman*,
F. L. CAMPBELL,
G. F. KNOWLTON.

On motion the Report of the Nominating Committee was accepted and the Secretary instructed to cast a ballot for the election of the persons nominated. This being done, they were duly elected.

Following the transaction of the above business, the meeting adjourned.

The following exhibits were on display in rooms near the meeting place of the Society:

1. Lepidoptera in Transpar Mounts. OTTO ACKERMANN, Irwin, Pennsylvania.
2. Hibernation of *Macrovelia horni*. ARTHUR P. MCKINSTRY, University of California, Davis, California.
3. Newer Methods of Printing, with Particular Reference to Entomological Needs and to the Reproduction of Illustrations. G. F. FERRIS, Natural History Museum, Stanford University, California.

Respectfully submitted,

CLARENCE E. MICKEL, *Secretary*.

ANNALS

OF

The Entomological Society of America

Volume XXXV JUNE, 1942 No. 2

COLEOPTEROCORIS, AN INTERESTING NEW GENUS OF THE SUBFAMILY POTAMOCORINAE

(Naucoridae: Heteroptera)

H. B. HUNGERFORD,[1]
University of Kansas,
Lawrence, Kansas

In 1941 Doctor Robert Usinger set up the new Subfamily Potamocorinae for *Potamocoris parvus* Hungerford, which was described in the same issue of the Annals of the Entomological Society of America, Vol. XXXIV, pp. 1–4, Plate I. This tiny species, only 2.8 mm. long, appeared to be a most interesting discovery, and remarkably smaller, and structurally different from any Naucorid known. Recently there has come to my attention another new species of about the same size, but with characters that place it in another genus and add strength to the suggestions of Doctor Usinger and Mr. W. E. China[2,3] that there is some close relationship between the Naucoridae and the Helotrephidae.

It is interesting to find the Potamocorinae, which are the most primitive of the Naucoridae, in South America, which is the home of both Paratrephes and Neotrephes which are Helotrephids, believed by Mr. China to more closely resemble the primitive proto-Helotrephidae than do any of the Old World forms. In his table showing the probable evolutionary lines of Helotrephidae, Mr. China suggests that the proto-Helotrephidae arose from the proto-Naucoridae. No doubt when there is a sufficient number of specimens of this strange new species, a morphological study will throw some light upon the problem.

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[1] Contribution of the Department of Entomology, University of Kansas.

[2] W. E. China, 1936, Annals and Magazine of Natural History, Ser. 10, Vol. XVII, pp. 537–8.

[3] W. E. China, 1940, Annals and Magazine of Natural History, Ser. 11, Vol. V, pp. 124–26, and table.

This new bug is without doubt a near relative of *Potamocoris parvus* Hungerford, and I was tempted to describe it as a new Potamocoris species. While specifically distinct we still have a question which we cannot settle, for we know *Potamocoris parvus* Hungerford from fully winged forms only, and the new species has the flight wings reduced as in most specimens of Plea, and the hemelytra are shield-like and meet in a straight line down the back without claval suture or embolium. The absence of a claval suture and a marked embolium in forms with aborted flight wings may not be of generic significance as has been shown for Helotrephes by Esaki and China[4], and for Neotrephes (Helotrephidae) by Mr. China[5]. Nevertheless, there are considerations that lead me to erect a new genus for this new insect. In the Naucoridae we have the genus Melloiella De Carlo which is separated from Ambrysus Stål by its greatly modified hemelytra, and in the Pleidae which have the hemelytra meeting in a straight line down the back, as in this new form, there is no difference in this character whether the flight wings are aborted or developed. I would expect therefore that in this new form, if flight wings are developed, the hemelytra will remain the same shape although a clavus may then be apparent.

Coleopterocoris new genus

Body moderately elongate. Head large, eyes small with coarse facets. Head set into the prothorax which embraces the lateral margins of the eyes at their base. Inner angle of eye remote from caudal margin of the head. Eyes curved over the lateral margin of the head to occupy nearly as much area beneath the head as above. Labrum transverse, set beneath the anterior margin of the head, apex rounded. Beak slender, 3-segmented, last two segments elongate. Antennae 4-segmented, slender, arising from beneath the mesal half of the caudo-ventral margin of the eyes. Gula long, not carinate, but broadly elevated. Pronotum with caudal margin plainly excavated in front of scutellum, which is short and transversely depressed at base. Hemelytra coreaceous, without embolium or clavus and meeting in straight line down the back. Prosternum moderately carinate. Mesosternum slightly carinate. Venter naked except for scattered hairs. All tarsi end in two claws; anterior tarsus one-segmented, others two-segmented.

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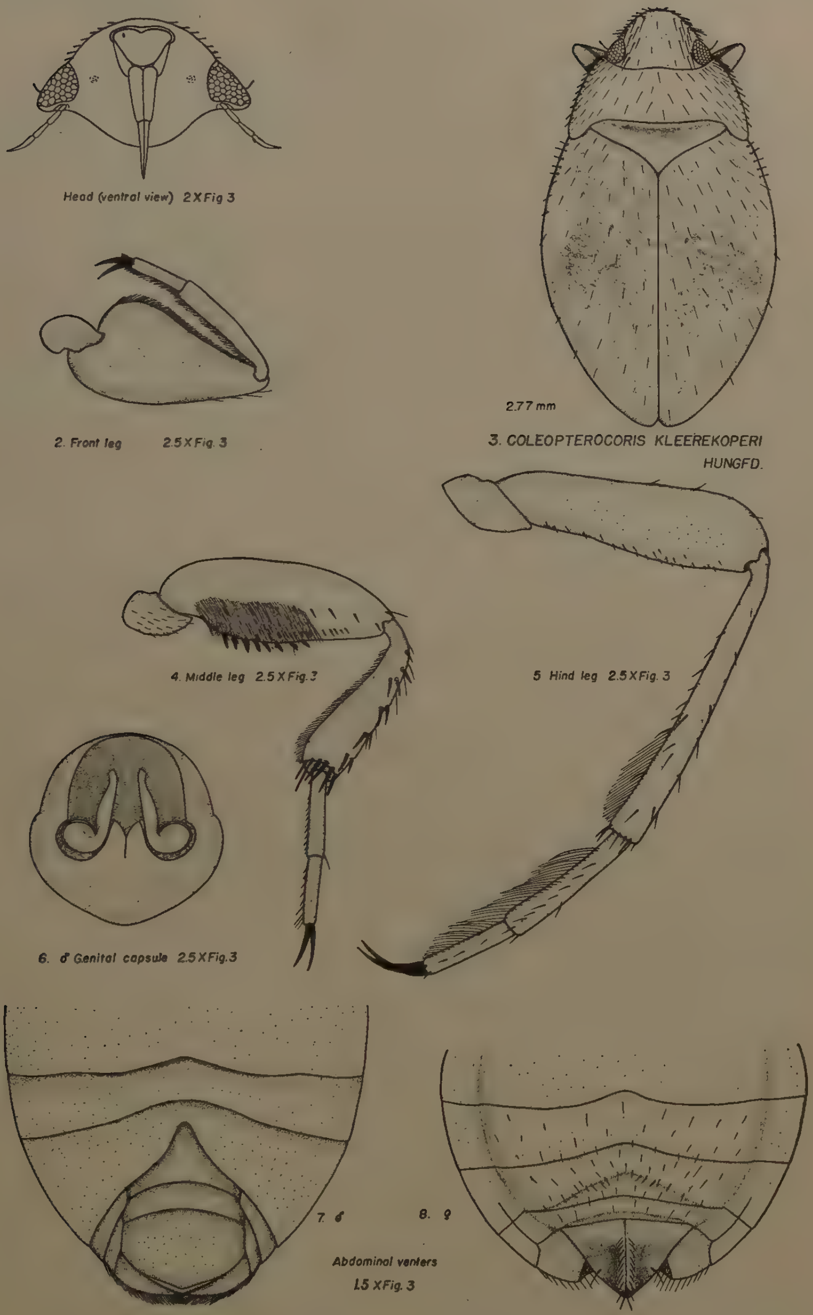
[4] T. Esaki and W. E. China, 1928; Eos Revista Espanola de Entomologia, IV, p. 135.

[5] W. E. China, 1940; Annals and Magazine of Natural History, Ser. 11, Vol. V, p. 106.

Coleopterocoris, n. g.
H. B. Hungerford

PLATE I


Head (ventral view) 2X Fig 3
2. Front leg 2.5X Fig. 3
2.77 mm
3. COLEOPTEROCORIS KLEEREKOPERI HUNGFD.
4. Middle leg 2.5X Fig. 3
5 Hind leg 2.5X Fig. 3
6. ♂ Genital capsule 2.5X Fig. 3
7. ♂
8. ♀
Abdominal venters 1.5X Fig. 3

Figs. 1 to 8. *Coleopterocoris kleerekoperi*, new genus and new species, Potamocrinae: Naucoridae.

Coleopterocoris kleerekoperi n. sp.

Size.[6]—Length, 2.77 mm.; width of head across the eyes, .79 mm. Anterior width of pronotum, .8 mm.; posterior width of pronotum, 1.26 mm.; greatest width across hemelytra, 1.85 mm. Median length of head, .58 mm.; of pronotum, .42 mm.; of scutellum, .357 mm.; of hemelytral commissure, 1.76 mm.

Color.—Stramineous with brown blotches on the hemelytra as shown in the figure. Some pink areas on pronotum, scutellum, and base of hemelytra due to closely placed pink flecks. Venter and legs stramineous.

Structural characteristics.—Head smooth, pronotum and scutellum faintly, and hemelytra plainly pitted, on basal half. Dorsal surface of insect with some fine procumbent hair and a few linear scale-like hairs on head, on upper margin of pronotum, on base of embolium, and one on lateral margin of each eye. Eyes small, coarsely faceted and curved over the lateral margin of the head to occupy as much area beneath the head as above. Inner margin of the eye rounded. Interocular space about three times the diameter of an eye. Head flattened, its front broad and produced beyond the eyes by a distance about equal to their length. Labrum broader than long, apex rounded. Beak moderately slender, reaching to distal end of anterior coxae. Antennae slender arising from beneath the mesal half of the caudo-ventral margin of the eyes, and extended beneath the lateral margins of the prothorax, more than half the length of the latter. If turned laterally the last segment, and part of the third, would be exposed from above. The relative lengths of antennal segments are as follows: 1st: 2nd: 3rd: 4th::5:10: 12:17. The second segment somewhat thicker than the others.

In lateral view the head and pronotum making a declivent curve matching that of the caudal third of the hemelytra. Dorsum of the insect broadly rounded or arched (not flat). Lateral margin of pronotum rounded and broadly explanate; the anterolateral angles acute and embracing at least one third of the eyes; scutellum small and transversely depressed behind the base. The prosternum with median longitudinal carina which is produced beyond the anterior margin. Mesosternum with slight median carina. Front legs short, femora moderately incrassate. The relative length of femur : tibia : tarsus :: 8.5 : 5.2 : 2.3; middle legs short with stout spines on femur and tibia, the relative length, femur : tibia : tarsus :: 7 : 7.5 : 5.5. Hind leg with swimming hairs on tarsus and distal half of tibia, the relative lengths, femur : tibia : tarsus :: 11 : 13 : 11.3. In both middle and hind legs the first tarsal segment is slightly longer than the second. The ventral abdominal segments and the male genital capsule as shown on the plate.

Location of types.—In the Francis Huntington Snow Collection of the University of Kansas. Described from three males and one female, and labeled Holotype, Allotype, and paratypes.

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[6] Measured Allotype—The overall length is measured as the insect rests on the mount. The length of head, pronotum, and scutellum are actual lengths. The hemelytral suture is measured by projection as insect rests on the mount. The Holotype is slightly smaller than the Allotype, but one of the paratypes is as large.

These four specimens and one nymph were collected by H. Kleerekoper in Brazil, South America in November, 1941; Nr. Porto Allegre.

Comparative notes.—This tiny Naucorid is undoubtedly related to *Potamocoris parvus* Hungerford, but resembles the family shape more characteristically. Like *P. parvus* it is very small, it has the slender scale like hairs, even on the eyes, its antennae and legs are much the same, and the male genital capsules are similar. It differs from *P. parvus* in having much smaller eyes, more explanate prothorax, small scutellum, hemelytra without clavus or corium, and meeting in a straight line down the back, more rounded dorsal surface, and the female abdominal venter lacks the V shaped depression so conspicuous in *P. parvus.* The nymph, which appears to be in the last instar, has the antennae three segmented, and all the tarsi are one-segmented with the swimming hairs confined to the hind tarsus. The repugnatory gland pores are on the rear margin of the third dorsal abdominal segment, and are well separated.

AUTOBIOGRAPHY OF AN OLD MAN, by W. D. FUNKHOUSER. Pages "*one*" to "sixty-four." 1941. Printed at Lexington, Ky., by the TRANSYLVANIA PRINTING CO., INC.

This is a privately printed whimsical sketch of the history of man. It is dedicated "to the memory of Tip—a mongrel, a friend of the human race and my companion for a quarter of a million years." Funkhouser for years the American authority on the Membracidae of the World is at present Dean of the Graduate School of the University of Kentucky. We first became acquainted with him while we worked at opposite sides of the same desk at Cornell. Then we learned we had been born in the same town two years apart, he the son of the Lutheran minister, the writer the son of the superintendent of schools. At Cornell we graduate students respected his thorough technique in the taxonomy of the Membracidae, admired his skill and power as a collegiate wrestler and enjoyed the dollar cigars his Cuban, Mexican and Central American students presented him as Principal of the Cornell Preparatory School (Cascadilla).

At the University of Kentucky Funkhouser found himself in a region spotted with the numerous camp sites, mounds and other remains of the Indians. Central Kentucky as discovered by Daniel Boone with its blue grass glades was probably the finest hunting ground in North America. The Indian remains indicate a rich country fought over by many tribes. These diversions drew Funkhouser from entomology for a period of years. His interest even developed to the point of an appointment as Professor of Anthropology.

The present little volume covers: 1. Old Men Dream Dreams; 2. My youth (400,000 years ago I was an Eolithic Man.); 3. The Long Trek (I was a Paleolithic Man.); 4. My Life in Africa (I was a Neolithic Man.); 5. We Migrate to Europe (I was an Explorer.); 6. Helvetia (I was an Alpine Man.); 7. America (I am a Civilized Man.). We do not know a more readable sketch of the descent of man. It is the whimsical, gracious philosophy of Funkhouser.—C. H. K.

ON THE MARRIAGE FLIGHT OF POGONOMYRMEX COMANCHE WHEELER

(Hymenoptera: Formicidae)

R. W. Strandtmann,
East Texas State Teachers College,
Commerce, Texas

On June 10, 1936, on the Brazos River bottom a few miles north of Waco, Texas (on Ruel Yowell's farm, to be exact), I was fortunate enough to observe the nuptial habits of the harvester ant, *Pogonomyrmex comanche* Wheeler. (Kindly identified for me by Dr. M. R. Smith of the U. S. Department of Agriculture.) They were found on a large pecan tree and so abundant that they completely covered the tree. Apparently mating occurred on the tree, or perhaps it originally occurred in the air and they settled on the tree after union.

The love life of this ant is by no means private. Each mated pair was covered by six to ten free males which by all appearances were trying desperately to dislodge the mated male and themselves copulate with the female. Through all this frenzied, chaotic scrambling of the superfluous males the female seemed interested only in maintaining a foothold on that particular part of the tree on which she happened to be. The male in copulo held on tenaciously. Clusters of these were continually dropping off and drifting to the ground, where they were so thick that I was able to pick up half a hundred specimens without moving. The scramble of the extra males went on as if nothing had happened.

To say that there were thousands of these ants would be an understatement. The pecan tree was large and its foliage was covered with ant clusters; the ground below looked as if covered with over-ripe fruit.

In three cases I dislodged all the extra males to get a better view of the mated pair. In each case the female immediately turned upon the male and chewed his abdomen until he was forced to relinquish his embrace. The female then began to preen herself. The male, however, commenced a frenzied search for his mate, but alas, when he found her she would have none of him, and she made it known in no uncertain terms. After a few rebuffs the male took wing, and the female soon followed suit. The male very likely went in search of another member of the opposite sex. Whether the female left for good or went in search of a new mate I cannot say.

THE LARVAL PILOTAXY OF CULEX PIPIENS WITH SPECIAL REFERENCE TO GENETICS[1]

THOMAS A. HART

INTRODUCTION

Much of the recent epidemiological work on human malaria and *Anopheles* has pointed to a need for more knowledge of the races of mosquitoes involved as well as of the parasites. Although much has been done in morphological, physiological, ecological, and biometric studies on the *Anopheles* mosquitoes, there have been serious drawbacks to genetic research with *Anopheles* because of their eurygamous habits; because individual selections and matings, so important in genetic work, are practically impossible; and because of the expense involved in housing them properly. In order to circumvent some of these difficulties a *Culex* mosquito was chosen for this study. *Culex pipiens* is relatively easy to maintain in the laboratory due to the existence of a stenogamous race in which individual matings after selection can be made. The particular one chosen and used throughout was a stenogamous and autogenous race. Any advances of biological significance made in the study of the species *Culex pipiens* may be related to the general problem of bird malaria. This in turn may serve as a foundation for similar observations within the field of human malaria.

This study was undertaken in order to establish a statistical base line from which comparisons among mosquito races within the species could be made. The morphological feature chosen for study was the pilotaxy of the fourth-stage larva of *Culex pipiens*, and the genetic significance of variations in a particular structure, the numbers of paired tufts on the siphon.

HISTORICAL

Since the beginning of the century there has developed in Europe and in America an interest in mosquito races—their physiological, morphological, and geographical differences. Sergent, in 1903, observed some morphological and physiological differences within the species *Anopheles maculipennis*. However, the first to suggest races within this species was Roubaud (1920, 1921), who observed morphological and physiological differences based on the number of maxillary teeth. He concluded that the zoophilic race possessed a greater number of maxillary teeth than did the androphilic race. Wesenburg-Lund (1921) concluded that zoophilism, caused by stall-feeding of cattle, was an environmental rather than a genetic effect. Grassi (1921) demonstrates the presence of Anophelism without malaria as developing from two races within the species (*maculipennis*) only one of which was androphilic. Further research on this subject by Missiroli and Hackett (1927) showed the presence of two definite biological races, one of which was zoophilic, the other indifferent. A later paper by Hackett (1937) reports observations on other species of *Anopheles* which show complexes within the species similar to those of *Anopheles maculipennis.*

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[1] From the Department of Bacteriology and Parasitology, The University of Chicago. This research was aided by a grant from the International Health Division of the Rockefeller Foundation to the University of Chicago. The author is indebted to Prof. Clay G. Huff under whose supervision the work was done.

Falleroni (1924, 1926) made the initial observations on the egg pattern of *Anopheles.* He found definite color distinctions which later showed racial cleavage into two definite forms. Based on Falleroni's studies were further observations by Hackett and Missiroli (1935) on morphological differences in egg pattern and color, on the hair arrangement of the second abdominal segment of the larvae, and on the shape of the ventral harpaginal spine of the male hypopygium. Finally Hackett (1937) demonstrated eight or nine distinct forms, in the species, based on egg pattern and color. At least seven of these races (Bates and Hackett, 1939) have been well established biometrically, genetically, and physiologically.

In studying the morphology of the adult, Van Thiel (1926, 1927) agreed with Swellengrebel (1924) as to the taxonomic importance of the long- and short-winged varieties.

The race question in *Anopheles maculipennis* is summed up by Bates (1940). He proposed that because of morphological and physiological differences the *maculipennis* populations be classified into species rather than races.

Shortly after work was begun on the study of races of anophelines observations on culicines were also initiated. In 1912 Neumann recorded oviposition in *Culex pipiens* without a blood meal. Huff (1929) in studying ovulation requirements for *Culex pipiens*, confirmed Neumann's earlier findings. However, a race not requiring a blood meal was not distinguished. Grassi (1923) and Legendre (1931a, 1931b, 1932) noted the occurrence of races within this species.

The first definite biological races of this species to be distinguished were those demonstrated by Roubaud and his associates in France (1929, 1930, 1930a, 1931, 1931a, 1933, 1934; Roubaud and Toumanoff 1930, 1930a; and Roubaud and Gaschen 1932). One of these races was anautogenous and eurygamous, the other was autogenous and stenogamous. Tate and Vincent (1936) investigating this problem found true biological anautogenous and autogenous races of *Culex pipiens.* By cross matings between the two races they showed the hereditary character of stenogamy and autogeny. Richards (1941) observed that *Culex pipiens* in the eastern United States shows a differentiation similar to that of the European species as regards stenogamy and autogeny.

Further study of these two races led to a description by Roubaud

(1935) of morphological differences in the egg floats. In the same year de Buck (1935), continuing the study of morphological differences, found that the number of teeth (scales) in the comb of the eighth larval segment in the typical race was greater than the number in the autogenous race.

Jobling (1936) found that the color of the autogenous adults was lighter than that of the anautogenous adults. Among the larvae he found the siphon of the autogenous race to be thicker and shorter than that of the anautogenous race; the same was true of the anal gills. The ventral brush of the autogenous race had more branches than that of the anautogenous race.

Huff (1927, 1929, 1930, 1931, 1934, 1935) showed other notable differences within this species. He found individual mosquitoes some of which proved to be susceptible, others to be refractory to bird malaria parasites. In one instance susceptibility proved to be a simple Mendelian recessive. In one experiment on color of the larvae Huff (1929) found that in the crossing of inbred strains of brown and green larvae the green was a Mendelian recessive.

MATERIALS AND METHODS

Male and female adult mosquitoes were kept in gauze-covered lantern globes over moistened cellucotton in a petri dish. Cooked raisins, placed on the gauze, served as food. Periodically canaries were secured to the top of the lantern globes to afford a blood meal for the females. On the third day thereafter these engorged females were placed over water so that they might oviposit. The eggs were removed to pans filled with distilled water. When the first larvae emerged, feeding was begun. The food consisted of a mixture of dried skim milk, yeast, and liver extract. This feeding continued through the fourth larval stage. After the larvae pupated the pupae were removed from the pans and placed in water-filled evaporating dishes under the lantern globes where the pupae became adults.

For studying the living larvae a temporary mount was made by ringing a large rectangular cover glass with paraffin, covering it with another cover glass, and placing the two of them on a slide. This method eliminated pressure on and decreased the activity of the larva which was enclosed with a drop of water inside the temporary mount.

Several methods were tried for killing and preserving the larvae to be studied for pilotaxy. The method adopted was one suggested by Hopkins (1936).

Fourth stage larvae were killed in hot 70 per cent alcohol. They were then put into fermentation tubes in a solution of lactophenol composed of 20 cc. of phenol, 20 cc. of lactic acid, 40 cc. of glycerine, and 20 cc. of distilled water. This method of preservation gave excellent definition of hairs and body structures. Since this preservative tended to soften the larvae the following method was adopted in order to eliminate pressure on the larva under observation. One large oblong cover glass was ringed with paraffin. On this ring a thin layer of vaseline was applied. A larva in a drop of lacto-phenol solution was placed within the ring. A second large oblong cover glass was used to cover the temporary mount. This mount was then placed on a glass slide, making possible the use of a mechanical stage in observations. The vaseline which held the two cover glasses together allowed them to be turned over for observations of the dorsal and ventral surfaces of the larva.

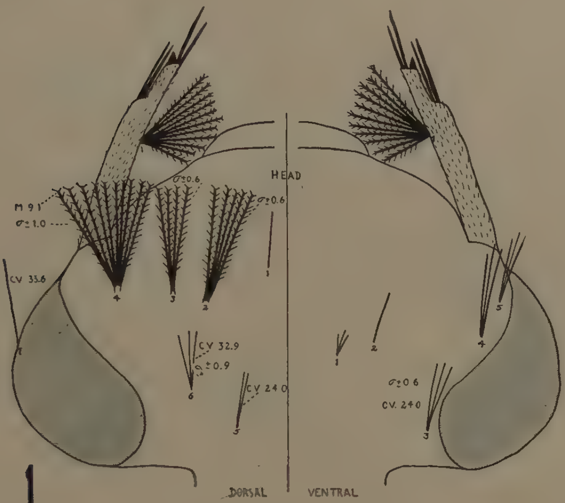
Since the oblique position of the siphon prevented a perfectly flat view of the dorsal and ventral surfaces of the larva, it was found advantageous to observe the siphon first and then remove it before observing the head, thorax, and segments of the larva. Each larva was put back into the lactophenol solution after observations were made.

OBSERVATIONS

Pilotaxy.—Using the above method a complete study was made of the pilotaxy of one fourth-stage larva. This study included the number, length, grouping, insertion, and branchings of the hairs on the antennae, head, thorax, segments and siphon. When this study was completed, a descriptive outline and a drawing of the sample larva were made to serve as a working guide for observations on one hundred additional larvae comprising a random sample. Based on these observations and the mathematical calculations of the mode for each character studied, a modal larva was described and drawn (figures 1, 2, 3, 4, and 5).

The system used for numbering the hairs followed Martini's (1923) method for the dorsal surface. The low numbers began at the mid-dorsal line (figures 1, 2, 3, 4) and ranged upward toward the lateral edge. Martini (1923) numbered the ventral surface hairs by beginning at the lateral edge with the next number in the series and ranging upward to the mid-dorsal line. The system adopted here differs from Martini's method in the use of the same numbering scheme for the ventral and dorsal surfaces. Since the eighth segment, the anal segment, and the siphon (figure 5) are in a different plane from the rest of the animal, with the surfaces placed laterally, the numbering system does not follow the plan used on the rest of the larva. On the eighth segment the hairs are numbered consecutively from left to right. On the siphon the hairs are numbered from proximal to distal ends. The anal segment has only one numbered hair.

Martini (1923), Root (1924), and Senevet and Abonnenc (1939) drew homologies between hairs of different segments in larvae of both culicine and anopheline mosquitoes. In this study some apparent homologies have been observed. The following hairs (figures 3, 4) of the dorsal surface of segments 2 to 7 seem to be homologous: Hair number 1 appears to be homologous on segments 2 to 7. Hair number 2 and hair number 6 appear to be homologous with corresponding hairs on segments 3 to 6. Hairs number 4 and 7 seem to be homologous with the hairs of the same numbers on segments 2 to 5. On the ventral surface (figures 3, 4) hair number 3 appears homologous to the corresponding hair on segments 3 to 5. On segments 2, 3, 4, 5, and 7 hair number 4 seems homologous from segment to segment. Before these homologies can be definitely established an intensive, comparative study should be made of the various larval stages in this species and of a considerable number of series of species in the genera.

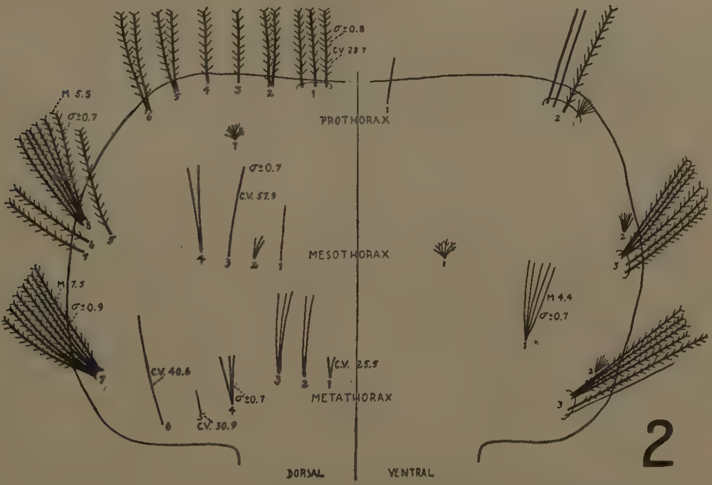

HEAD
M 9.1
σ±1.0
σ±0.6
σ±0.6
CV 33.6
4
3
2
1
CV 32.9
σ±0.9
6
CV 24.0
5
1
2
5
4
σ±0.6
CV. 24.0
3
DORSAL
VENTRAL

1

Fig. 1. Pilotaxy of *Culex pipiens* larva. Dorsal view of head. L & ventr

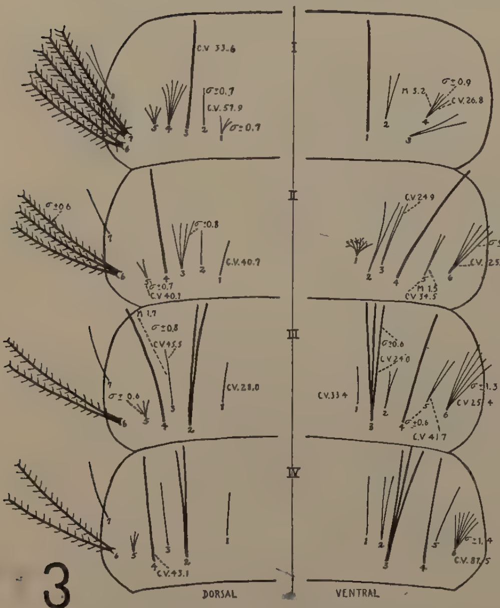
C. V. Coefficient of variation.
σ. Standard deviation.
M. Mean.

On all the drawings (Figs. 1, 2, 3, 4, and 5) only the upper quartile figures were used for the coefficient of variation and the standard deviation. This accounts for the absence of these figures on most of the hairs. The mean was added to those hairs or hair groups in which it differed from the mode as much as 0.5 or more. The drawings express the modal arrangement of hairs. The number at the base of each hair or hair group follows the system explained in the text.

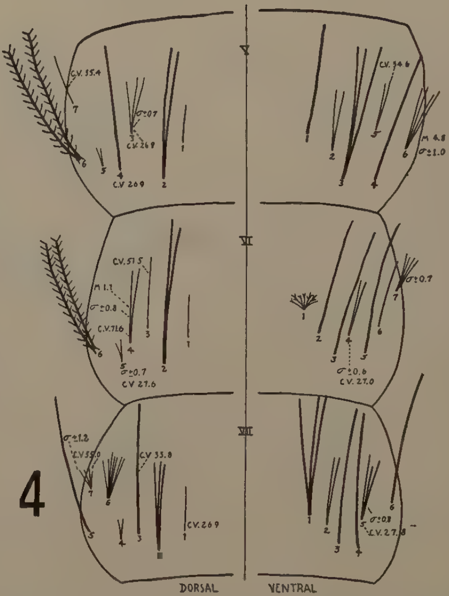

σ±0.8
CV 28.7
6
5
4
3
2
1
1
2
PROTHORAX
M 5.5
σ±0.7
1
σ±0.7
C.V. 57.9
8
6
7
4
3
2
1
MESOTHORAX
1
2
3
M 7.5
σ±0.9
M 4.4
σ±0.7
1
7
C.V. 40.6
σ±0.7
3
2
1
C.V. 25.5
METATHORAX
2
3
6
5
C.V. 30.9
4
DORSAL
VENTRAL

2

Fig. 2. Pilotaxy of *Culex pipiens*. Thorax, dorsal view. L & Ventral
See legend, fig. 1, for terms.


I
II
III
IV
C.V 33.6
σ±0.7
C.V. 57.9
σ±0.7
M 3.2
σ±0.9
C.V. 26.8
σ±0.6
σ±0.8
C.V. 40.7
σ±0.7
C.V 40.1
C.V 24.9
σ±1.0
C.V. 25.9
M 1.5
CV 34.5
M 1.7
σ±0.8
C.V 45.5
σ±0.6
C.V. 28.0
σ±0.6
C.V 24.0
C.V. 33.4
σ±1.3
C.V 25.4
σ±0.6
C.V 41.7
C.V. 43.1
σ±1.4
C.V. 87.5
DORSAL
VENTRAL

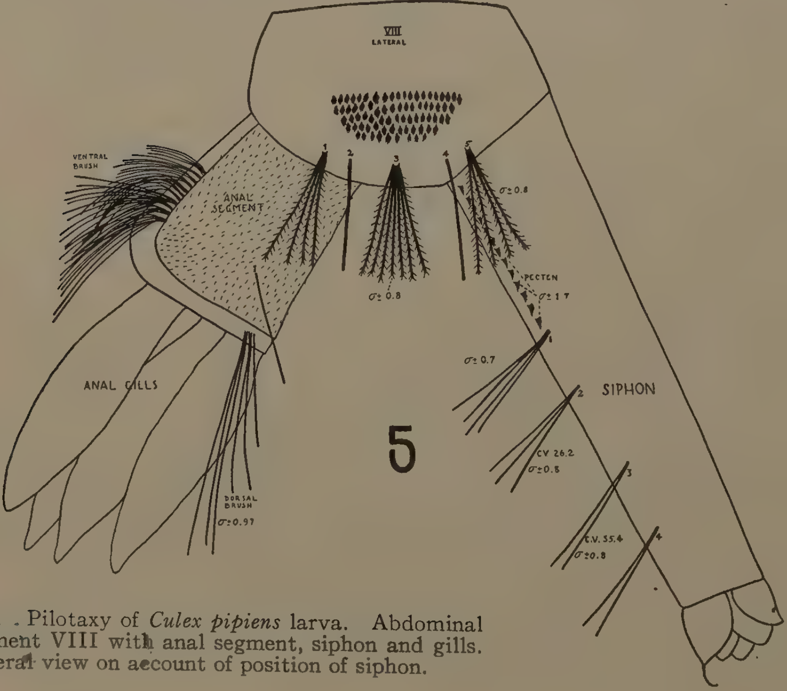
3


V
VI
VII
C.V. 35.4
σ±0.7
C.V. 26.9
C.V 26.9
C.V. 34.6
M 4.8
σ±1.0
C.V. 51.5
M 1.1
σ±0.8
C.V. 71.6
σ±0.7
C.V 27.6
σ±0.7
σ±0.6
C.V. 27.0
σ±1.2
C.V 55.0
C.V 33.8
C.V. 26.9
σ±0.8
C.V. 27.8
DORSAL
VENTRAL

4

Fig. 3. Pilotaxy of *Culex pipiens*. Abdominal segments I, II, III and IV, dorsal view.
Fig. 4. Pilotaxy of *Culex pipiens*. Abdominal segments V, VI, VII and VIII, dorsal view. (See legend, fig. 1, for terms used.)

LL
L &
Ventr


VIII
LATERAL
VENTRAL BRUSH
ANAL SEGMENT
σ±0.8
σ± 0.8
PECTEN
σ±1.7
σ± 0.7
SIPHON
CV 26.2
σ±0.8
C.V. 35.4
σ±0.8
ANAL GILLS
DORSAL BRUSH
σ±0.97

5

Fig. 5. Pilotaxy of *Culex pipiens* larva. Abdominal segment VIII with anal segment, siphon and gills. Lateral view on account of position of siphon.

STATISTICAL TECHNIQUES

The data from the observations were used to calculate the mean, the standard deviation, the coefficient of variation, and the standard error of the mean for each hair or hair group on the 101 larvae observed.[2] There was a total of 146 different hairs or groups of hairs on the ventral and dorsal surfaces of each larva. Since the animal is bilaterally symmetrical, a total of 292 were observed, and the calculations already mentioned were made for each individual larva. It was found that the total range for the coefficient of variation for all hairs or hair groups was from 0.0 to 87.5 per cent. The total range for the standard deviation was from 0.0 to 1.7. The range of the difference between the mode and the mean was from 0.0 to 0.9. However, on the average, the difference between the mode and the mean was found to be only 5.8 per cent of the mean. Only the upper quartile figures for the coefficient of variation and standard deviation were used on the drawings. In the range of differences between the mode and the mean only those differences of 0.5 or more were added to the drawings.

TABLE I[3]

SELECTED EXAMPLES OF VALUES IN WHICH THE COEFFICIENT OF VARIATION ASSUMES AN UNUSUAL MAGNITUDE DUE TO THE LOW VALUE OF THE MEAN

Hairs	Coefficient of Variation	Standard Deviation	Mean
Dorsum of head—Hair No. 6	32.9	0.9	2.7
Dorsum of mesothorax—Hair No. 3	57.9	0.7	1.7
Dorsum of segment I—Hair No. 2	57.9	0.7	1.1
Dorsum of segment II—Hair No. 5	40.1	0.7	1.7
Dorsum of segment III—Hair No. 3	45.5	0.8	1.7
Ventrad of segment IV—Hair No. 6	87.5	1.4	1.6
Dorsum of segment VI—Hair No. 4	71.6	0.8	1.2
Dorsum of segment VII—Hair No. 7	35.0	1.2	3.6
Siphon:			
Hair No. 2	26.2	0.8	3.2
Hair No. 3	35.4	0.8	2.3

Since the coefficient of variation is a function of the standard deviation and the mean, it follows that if the standard deviation has a fairly fixed value while the mean changes, the coefficient of variation will change reciprocally. However, since the mean was often close to unity in this study, the changes effected in the coefficient of variation by changes in the mean were of an order greater than is usually seen in ordinary statistical computations. Therefore, while the coefficient of variation is in this case the more meaningful measure of variability it must be remembered that the means encountered are often of a very low order and consequently the coefficient of variability rises to values higher than would be expected in ordinary statistical material in which the mean is more frequently higher. Table I shows selected cases from the data of this study which illustrate these facts.

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[2] The complete data for all observations and calculations are being deposited with Prof. C. G. Huff, Department of Bacteriology and Parasitology, University of Chicago.

[3] The figures for this table are taken from data which are being deposited with Prof. C. G. Huff, Department of Bacteriology and Parasitology, University of Chicago.

COMPARISON OF THE LABORATORY STRAIN WITH A WILD POPULATION

As an initial step in the analysis of the species by biometrical studies of the pilotaxy, a comparison was made between the laboratory population and a wild population with respect to siphonal characters.

TABLE II

Comparison of Siphonal Hair Group Distributions in the P_1 Generation of the Laboratory Strain With Those of the Wild Strain

Strain	Percentages of				Total No. of Larvae
	3 Paired Tufts	4 Paired Tufts	5 Paired Tufts	Unpaired Tufts	
Laboratory	5.2	63.7	0.0	31.0	1,649
Wild	3.0	75.0	2.0	20.0	100
Difference	2.2 ± 2.2	11.3 ± 4.8	2.0 ± .33	11.0 ± 4.6	

By examining Table II it may be seen that the three-paired tufts, the four-paired tufts, and the unpaired tufts in the two strains do not show clearly significant differences, but in the case of the five-paired tufts the difference is significant.

Observations were made on the number of pecten teeth in the same hundred fourth-stage wild *Culex pipiens* larvae. The same statistical calculations were made for these data as were made for the data on the laboratory strain. The ranges for the number of pecten teeth were from 9 to 17 in both cases. The mode was 13 for both strains. The mean for the laboratory strain was 12.8; the mean for the wild strain was 12.7. The two populations would, therefore, appear to be identical with regard to this character.

The effect of selective breeding on numbers of siphonal hair tufts.—For the selection experiment on the living larvae the siphon was chosen because it was the largest, clearest part of the larvae and the one with the simplest arrangement of hair groups. However, the variation in hair groups was not as large as in some other structures. Technical difficulties were also a factor in determining the choice of the siphon in preference to any other structure.

During previous observations on preserved specimens of *Culex pipiens* fourth-stage larvae it was found that the mode for the arrangement of hair sets on the siphon was four groups bilaterally placed. A number of larvae were found with three bilaterally placed groups of hairs. A few larvae had five bilaterally placed groups of hairs. A large number had asymmetrically arranged hair groups in various combinations, such as four on one side, three on the other; four on one side, five on the other; three on one side, five on the other; three on one side, two on the other. The bilateral arrangement of three hair groups on the siphon was chosen for the selection experiment because the four bilaterally placed groups were the modal arrangement of siphon hairs; because the asymmetrically arranged grouping of hairs was too variable, and not as subject to statistical analysis; and because the number of larvae with five bilaterally placed groups of hairs was too small.

Beginning with the W-stock strain and continuing through the P_1, F_1, F_2, and F_3 generations, selection was made of larvae having siphons with three bilaterally placed groups of hairs. A fourth-stage larva was chosen at random from the W-stock strain. It was placed in a temporary mount and observed under low power. The number of hair groups on the siphon was ascertained, and the larvae with 3 paired hair tufts were segregated. All larvae with 4 paired or unpaired tufts selected from each generation were discarded because in this experiment they were not of any genetic importance. The larvae with 3 paired tufts selected from the W-stock strain constituted the P_1 generation. As these larvae pupated they were transferred to water-filled evaporating dishes under gauze-covered lantern globes. As soon as sufficient numbers of male and female adults had emerged the females were given a blood meal. On the third day thereafter the globes containing the fed females were placed over water so that they might oviposit. The eggs thus obtained were the beginning of the F_1 generation. Each succeeding generation was similarly treated, and the same procedure used in selection of P_1 larvae from the W-stock strain was followed for the F_1, F_2, and F_3 generations. At a point in the selections on the F_3 generation isolation procedures were instituted for egg rafts for the purpose of attempting to establish a homozygous strain. Of the five egg rafts isolated, three were infertile. Selection of larvae which developed from the other two egg rafts showed a distribution of 3 paired, 4 paired, and unpaired tufts not essentially different from those of egg rafts not isolated. As the F_3 larvae pupated they were isolated in test tubes partly filled with distilled water and plugged with cotton. Upon emergence the adults were placed in pairs, one male and one female, in lantern globes. Of the several attempts to induce the females of the isolated pairs to take a blood meal, only one was successful. The eggs from this female were infertile. Isolation of adult pairs in test tubes was tried also but this proved to be no more successful than isolation in lantern globes. Attempts to feed were continued until all the isolated pairs had died. The adults which developed from these select larvae seemed to be weak. Consequently one group of adults died before another group matured. This made it impossible to build up a substantial colony in this generation.

The mass selection experiment on larvae with 3 paired tufts on the siphon began with the W-stock on March 19, 1941. The experiment was terminated August 4, 1941, with the selected inbred F_3 generation. Table III summarizes the results of the experiment.

TABLE III

RESULTS OF MASS SELECTION EXPERIMENT FOR THE THREE PAIRED TUFT CHARACTER ON THE SIPHON OF THE LARVAE

GENERATION	NUMBER OF LARVAE WITH:			TOTAL	PERCENTAGE 3 PAIRED TUFTS
	3 Paired Tufts	4 Paired Tufts	Unpaired Tufts		
P_1	86	1,051	512	1,649	5.2
F_1	150	1,122	750	2,022	7.4
F_2	116	818	576	1,510	7.7
F_3	42	75	86	203	20.7

Male mosquitoes were chosen from the P_1, F_1, F_2, and F_3 generations. These were killed, cleared, and mounted to show genitalia. Each of the males chosen at random proved to be *Culex pipiens*. These observations were made and recorded in order to be certain that the animals with which the study ended were of the same species as those used to begin the study.

DISCUSSION

The data presented in this study and the statistical analysis of these data lay a groundwork for a quantitative analysis of the species by use of clearly visible morphological characters. The statistical data described here have served to establish norms for the laboratory strain of *Culex pipiens* as regards pilotaxy. In general, these norms agree with the findings of systematic culicidologists who arrived at their conclusions through less quantitative methods. This agreement shows that the characters of the larva known to be best for species identification show a low degree of variability. Extensive examination of the pilotaxy of this species is needed. Analysis of a wide-spread species revealing valid, small differences would lead to a more complete understanding of speciation in this group of mosquitoes. The population comparisons made thus far have been in two groups separated by only 10 miles. Although these two groups were very similar in pilotaxy, it is important to note that one significant difference was found in a siphonal character.

In the selection experiment the morphological character used was found to be determined to some degree, at least, by genetic factors. The fact that susceptibility in these mosquitoes has also been established as hereditary opens up the possibility of a correlation between these two characters which might aid in the solution of the more complex problem of malarial epidemiology. Information and techniques discovered in the field of avian malaria could probably then be applied to *Anopheles* and human malaria.

SUMMARY

Observations were made on the pilotaxy of 101 prepared specimens of a stenogamous, autogenous laboratory strain of *Culex pipiens* fourth-stage larvae.

The mode, the mean, standard deviation, and coefficient of variation were calculated for each individual hair or hair group.

A selection experiment, based on siphonal hair groupings, was performed. The non-modal arrangement of three bilaterally placed hair groups was chosen. Selection and inbreeding for this character through four generations showed a continually increasing percentage. These findings indicate that the character is hereditary.

To serve as an initial attempt at an analysis of the pilotaxy of the species as a whole, a comparison was made between the laboratory population and a wild population in respect to 5 pilotaxic characters. In this study it was found that there was a significant difference in one character out of the 5 studied, even though the populations were very close together geographically.

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NOTES ON TABANIDAE (DIPT.) FROM PANAMA

VII. THE SUBGENUS NEOTABANUS AD. LUTZ[1,2]

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Subgenus **Neotabanus** Ad. Lutz

1909, Inst. Oswaldo Cruz em Manguinhos, p. 29. (Type, designated by Bequaert.) 1924, *T. trilineatus* (Latr.). Not *Neotabanus* Ricardo, 1911.
Taeniotabanus Kröber, 1930, Dipt. Patagonia and S. Chile, Part 5, fasc. 2, p. 140. (Type, designated by Borgmeier, 1933, *T. occidentalis* L.).

Neotabanus was proposed by Adolfo Lutz in 1909 for a group of 18 Neotropical species of Tabanus. In subsequent papers (1913, 1914, 1914a, 1914b, 1922 and 1928), he defined the group by means of keys and added several species to it. Later workers have had some difficulty in deciding whether the name should be used in a generic or subgeneric sense or discarded altogether. Bequaert (1924, 1933, 1940), Enderlein (1925), Kröber (1933, 1934) and Stone (1938) have all discussed the matter to some extent. Kröber's statement (1933) that the color pattern of the abdomen is about the only character which can be used to separate the group seems to sum up the situation fairly well.

For the purposes of the present paper, the group may be characterized as follows: Eyes generally bare in the female, often hairy in the male. Frons narrow to rather broad. Third antennal segment with a dorsal tooth or angle, but without a long spine. Labella large and membranous. Subepaulet with macrotrichia, wing venation normal, but with a tendency to develop a spur vein or appendix on the upper branch of the third vein. Abdomen with markings in the form of longitudinal stripes or rows of contiguous truncated triangular spots, light on a dark ground. The color pattern of the eye in life is also quite distinctive, consisting generally of three green bands on a purple ground. In North America the group is connected with *Tabanus*, sensu stricto, by such forms as *T. vicarius*

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[1] Printing costs paid by the Gorgas Memorial Laboratory, Panamá, R. de P.

[2] No. VI. This journal, 34: 639–646, 1941.

Walk., *T. acutus* Big., and *T. fulvulus* Wied., while in Tropical America species such as *T. unistriatus* Hine, *T. angustivitta* Kröb. and *T. hookeri* Knab. form connecting links with other groups. In fact, it is difficult or impossible in some cases to decide whether a given species should be placed in the group or not. Thus although *T. hookeri* has a quite different eye pattern, and the abdomen is hardly striped, it is retained here for convenience, while *T. vicarius* and its allies which have striped abdomens, but eyes with but a single narrow dark band, are omitted.

Specific differentiation within the group is exceedingly difficult, as there appears to be a great deal of variation, while what differences there are seem mostly of degree. Eye characters of the male appear to offer the surest basis for separation, but this may be due to the small number of males available for study. The relative proportions of the frons, and color characters, especially of the abdomen and legs, have been the most useful in separating the females.

The nomenclature of the group is highly involved, as a great majority of the earlier descriptions are too brief to differentiate between closely allied species. The group as a whole is a dominant one, and its species generally furnish a goodly percentage of the specimens taken by any collector in the American tropics, so that nearly all the earlier dipterists described one or more species. I have been able to find 51 names which seem to apply to members of the group. Of these Kröber recognized 23 in his 1933 paper, and in 1934 listed 36, of which he claimed to have seen the types of 17. In Hine's collection there are a number of specimens labelled "comp. with Type," but for various reasons they do not help much in elucidating the tangle. Hine's other determinations for the most part do not agree with those of Kröber.

In selecting names for the Panama species, I have given priority to those names of which type material exists, or of which material determined by the author of the species exists, or on which there seems to be a general concensus of opinion. In many cases these are probably not the earliest names, but since the types of so many of the early names are lost or unrecognizable, it has seemed better to choose the moderate certainty of a possible synonym rather than the complete uncertainty of a Linnean or Fabrician name. Under each species, therefore, only those references which probably refer to the species considered are given. In addition to the Panama species, I have included a number of North and South American species of which I have material before me.

KEY TO NEOTABANUS FEMALES

1. Subcallus denuded, shiny. Frons narrow and convergent. Species small, less than 12 mm. . . . . 5. (**callosus** group)
   Subcallus pollinose, or if shiny, then frons very broad. 2
2. Size small, 11 mm. or less. Subcallus always pollinose. 4
   Size larger, generally from 12 to 18 mm. 3
3. Frons from 2½ to about 3⅔ times as high as wide, the callus at least as wide as high, nearly or quite as wide as frons. Median stripe a slender line or a series of triangles. Lateral stripes very markedly step-like, 9. (**hookeri** group)
   Frons variable, generally at least 5 times as high as wide, but if wider, then the median stripe broad, nearly parallel sided and the lateral stripes at most somewhat irregular. Callus never as wide as frons. . 11. (**lineola** group)
4. Very small, about 9 mm. Frons narrow, over 5 times as high as basal width, convergent. Basal part of third antennal segment disc-like. Median abdominal stripe a series of broad triangles, laterals a series of broad patches. . . . . **enanus**
   Larger, 9–11 mm. Frons broader, antennae normal, abdominal stripes well marked and rather even . . . .(See separate key) (**curtus** group)
5. Abdomen black with a uniform mid-dorsal white stripe; lateral stripes absent. Fore coxae and all femora black. . . . . **unistriatus**
   Abdomen with lateral stripes 6
6. Wings smoky. Median abdominal stripe of narrow contiguous truncate triangles, lateral stripes not step-like, but formed of a series of short streaks in line . . . . **fumatipennis**
   Wings hyaline 7
7. Median abdominal stripe of narrow truncate triangles, lateral stripes of oval spots in line. Palpi brownish. Coxae and femora black. Abdomen dark brown . . . . **callosus**
   Median abdominal stripe uniform, parallel sided. Lateral stripes continuous, parallel sided. Abdomen brownish yellow 8
8. Fore coxae and basal halves of mid and hind femora black. . . . **lucidecallosus**
   Fore coxae and mid and hind femora entirely reddish yellow. . . **restrepoensis**
9. Subcallus denuded, shiny. Frons convergent. Abdomen yellowish, a small integumental black patch on the first and second tergites. Median stripe a series of triangles; lateral stripes a series of oblique patches. . **hookeri**
   Subcallus pollinose. Frons nearly parallel sided. 10
10. Coxae and femora largely black. Scutellum black. Median abdominal stripe a slender even line. . . . . **johannesi**
    Coxae and femora pale. Scutellum reddish. Median abdominal stripe a series of contiguous triangles . . . . **angustivitta**
11. Median abdominal stripe of a series of narrow contiguous truncate triangles. Lateral stripes a series of oval or oblique rhomboid patches, which may or may not be contiguous 12
    Median abdominal stripe even and parallel sided. Lateral stripes as above, or practically even and parallel sided 16
12. Thorax striped, sometimes rather faintly so. Wings always entirely hyaline. Scutellum sometimes reddish 13
    Thorax always unstriped. Wings variable, often faintly smoky, or costal cell yellowish, or with very faint clouds on cross-veins. 15
13. Frons nearly parallel sided, 6½ times as high as wide. Coxae and femora largely blackish. Fore tibiae not prominently bicolored, the basal half light brown, the apical half dark brown. Scutellum black. Median abdominal stripe a series of rather broad white haired truncate triangles, lateral stripes a row of unconnected, oval white haired patches which are not oblique . . . . **dunni** (Panama)

Frons rather convergent below. Fore tibiae prominently bicolored. Lateral stripes variable, but either the spots contiguous or oblique. 14

14. Scutellum black. Frons quite narrow. . .(North America) **lineola** var. **lineola**

Scutellum reddish. Frons quite broad. .**lineola** var. **scutellaris; vittiger** var. **A.**

15. Wings with cross-veins faintly clouded. Palpi acutely pointed, (Central America) **maya**

Wings hyaline, smoky, or costal cell yellowish, cross-veins not clouded. Palpi rather blunt . . . .(Southern South America) **triangulum**

16. Callus over twice as high as wide with a prominent raised ridge extending from it over half way to vertex. Third antennal segment very slender, four times as long as greatest width. Thorax striped. Median abdominal stripe uniform, lateral stripes a series of unconnected oval spots which are not oblique. Size very large for the group, 18 mm., (Southern Brazil) **strigimacula**

Size seldom if ever exceeding 15 mm. Antennae never so slender. Callus broader, its dorsal extension shorter, weaker and usually unconnected. . . .17

17. Wings hyaline. Thorax striped, sometimes faintly, scutellum blackish. Fore coxae and mid and hind femora entirely pale. Mid stripe broad, even or slightly irregular, lateral stripes irregular, both always chalky white. Whole insect grayish in tone. . . . .**amplifrons**

Without the above combination of characters 18

18. First antennal segment rather inflated when viewed from above. Frons not or only slightly convergent. Callus square or rounded. Costal cell often yellowish. First tergite and generally the second with a black dorsal patch. Stripes variable, the mid-stripe nearly always quite narrow, often irregular, the laterals usually step-like, never perfectly even. Fore coxae and posterior femora at base always blackish. Scutellum very rarely reddish. Color variable, yellow, red or black, **triangulum**

Without the above combination of characters 19

19. Frons 3¾ to 4¼ times as high as wide, markedly convergent below. Frontal callus large, yellow. Scutellum reddish at apex. Fore coxae and posterior femora wholly yellow. Abdominal stripes broad, even, yellow. Whole insect yellowish brown. Wings entirely hyaline, (Central and S. America) **vittiger** var. **guatemalanus**

Without the above combination of characters 20

20. Whole insect rather grayish, thorax striped, scutellum reddish. Frons about 4½ times as high as wide, callus black, rectangular. Fore coxae and posterior femora extensively black. Stripes white, (North America) **vittiger** var. **A.**

Without the above combination of characters, (See separate key) **lineola** and vars.

KEY TO NEOTABANUS MALES

1. At least area of enlarged facets of eye definitely pilose under a hand lens. . . . 2

Eye entirely bare, at most short scattered hair visible under high power magnification 7

2. Enlarged facets of eye much larger than small facets, occupying about ⅔ of total eye area, the line of demarkation between the two types very abrupt 3

Enlarged facets of eye at most only two or three times as large as small facets, occupying about ½ eye area, the line of demarkation not clearly defined 5

3. Frontal triangle bare and shiny. Median stripe a series of white haired triangles, lateral stripes a row of unconnected oblique spots. Fore coxae and posterior femora pale yellowish . . . .**hookeri**

Frontal triangle pollinose 4

4. Whole insect predominantly greyish. Stripes white, at least the laterals step-like. Fore coxae and posterior femora extensively dark, (Southeastern N. America) **vittiger** var. **schwardti**

Whole insect predominantly yellowish brown. Stripes yellowish, the laterals at most slightly irregular. Coxae and femora all yellowish, (Central and South America) **vittiger** var. **guatemalanus**

5. All coxae, and all femora, except extreme apices, black. Abdomen black, the median stripe a very slender line, the lateral stripes a series of oblique patches, both white haired . . . . **johannesi**
At least mid femora ⅓ pale. Abdomen not so marked 6
6. Whole insect greyish. Abdominal stripes broad and quite even, chalky white haired . . . . **amplifrons**
Whole insect predominantly brown, yellowish to nearly black. Median stripe narrow, irregular, lateral stripes oblique, step-like, both yellow to orange haired . . . . **triangulum**
7 Enlarged facets of eye much larger than small, occupying about ⅔ of total eye area, the line of demarkation between the two types very abrupt 8
Enlarged facets at most only two or three times as large as small, occupying about ½ eye area, the line of demarkation not clearly defined 9
8. Fore coxae and posterior femora wholly yellow. Abdomen yellow, brown haired, the median stripe broad and yellow, the laterals even, yellow, (Tropical America) **lineola** var. **carneus**
Fore coxae blackish, posterior femora blackish at base. Stripes and coloration rather variable . . . . (North America) **lineola** var. **lineola**
9. Fore coxae and posterior femora wholly yellow 10
Fore coxae and at least basal ⅓ of posterior femora blackish 11
10. Size small, less than 12 mm. Thorax brown. Abdomen yellowish brown, a small dark area beneath scutellum, often extending on to second tergite. Stripes even or slightly irregular, yellow haired, intervals black haired. Legs pale brown . . . . **stuppeus**
Size larger. Whole insect greyish or brown. Thorax striped. Scutellum reddish. Abdominal stripes narrow, irregular and whitish, (North America) **lineola** var. **scutellaris**
11. At least the median abdominal stripe rather broad and even. Wings often smoky or brownish along veins 12
Median stripe a series of contiguous triangles, lateral stripes of oblique step-like patches. Wings hyaline or with very faint clouds on crossveins . . 13
12. Abdomen yellow, black haired. The stripes rich yellow. Median stripe rather broad, laterals reduced. Legs largely yellow, (Central and South America) **lineola** var. **stenocephalus**
Abdomen black or largely so, stripes white. Legs largely blackish, (Tropical America) **lineola** var. **plangens**
13. Abdomen with a broad mid-dorsal black stripe underlying the vestiture; sides reddish. Mid-stripe of white haired contiguous triangles, lateral stripes of oblique unconnected white haired patches. Wings entirely hyaline . . . . **angustivitta**
Abdomen yellowish with a black triangle on the first two tergites underlying the vestiture. Stripes much as in *angustivittata*, but the laterals less disconnected and oblique, all yellow haired. Wings with very faint clouds on crossveins . . . . **maya**

Tabanus (Neotabanus) enanus n. sp.

(Pl. I, fig. 8)

Female—Length 9 mm., of wing 7.5 mm.

Frons about 5¼ times as high as basal width, somewhat narrower below, yellowish grey pollinose above and below, with an area of darker pollinosity about the median callus. Basal callus approximately square, as wide as frons, black, and with a wrinkled surface. Median callus spindle shaped, reaching half the distance to the vertex and unconnected with the basal callus. Vertexal tubercle absent. Subcallus pollinose. Eyes bare, green, with a median and an incomplete upper purple stripe, and the lower, outer and upper margins purple.

First antennal segment white, cap shaped and clothed with black hair; second segment scale-like. Basal part of third segment as wide as long, almost disc shaped, yellow, the dorsal angle very obtuse. Annulate portion about as long as the basal, black. Face and cheeks greyish white, white haired. Palpi yellowish, mostly black haired, and drawn out into a slender pointed apex. Proboscis black, short, the labella fleshy and occupying nearly three-fourths the length of the proboscis.

Thorax blackish grey, grey haired, and with scattered irridescent scale-like hairs. Scutellum and antealar tubercles concolorous with the dorsum. Wings completely hyaline, the stigma yellowish. A short stump on the upper branch of the third vein. Subepaulet with macrotrichia. All coxae, all of fore femora, and basal two-thirds of mid and hind femora black. Fore tibiae half black and half yellow. Mid and hind tibiae yellow; all tarsi brown.

Abdomen black, sides of the second to fourth tergites broadly reddish. A mid-dorsal row of yellow haired contiguous triangles, and a pair of lateral step-like yellow haired stripes overlie the ground color. The posterior margins of the tergites are also yellow haired. Beneath, the abdomen is dull reddish, with a black spot on the base of the first sternite, and the terminal sternites black.

Holotype ♀, Bejuco, Panama Province, Rep. of Panama, May 21, 1940.

This is quite the smallest *Neotabanus* known to me. It shows much resemblance to some species of *Stenotabanus*, but the subepaulet is hairy, and the eye pattern is like other *Neotabanus*. The specimen was taken in an extensive patch of mangrove swamp.

Tabanus (Neotabanus) curtus Hine

(Pl. I, fig. 11)

Tabanus curtus Hine, 1920, Ohio Journ. Sci., XX, 6, p. 190. Kröber, 1934, Rev. Ent., IV, 3, p. 292 (not recognized).

I have examined the types in the Hine collection and in the Philadelphia Academy of Natural Sciences, and a topotype is

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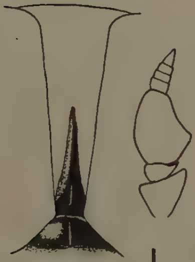
EXPLANATION OF FIGURES

All figures are of the frons and antenna of female specimens, and all are to the same scale. The vestiture of hairs on the basal antennal segments has been omitted, as it is quite uniform throughout the groups, and would only obscure the shape of the segments.

PLATE I

Fig. 1. *T.* (*N.*) *lucidecallosus* sp. nov. Holotype. Fig. 2. *T.* (*N.*) *unistriatus* Hine. Chiriqui Panama. Fig. 3. *T.* (*N.*) *fumatipennis* Kröb. Canal Zone, Panama. Fig. 4. *T.* (*N.*) *callosus* Macq. Rio Branco, Amazonas, Brasil. Fig. 5. *T.* (*N.*) *strigmaculus* sp. nov. Holotype. Fig. 6. *T.* (*N.*) *johannesi* sp. nov. Holotype. Fig. 7. *T.* (*N.*) *angustivitta* Kröb. Panama. Fig. 8. *T.* (*N.*) *enanus* sp. nov. Holotype. Fig. 9. *T.* (*N.*) "*pallidefemoratus* Krob." Panama. Fig. 10. *T.* (*N.*) *despectus* n. sp. Rio Branco, Amazonas. Fig. 11. *T.* (*N.*) *curtus* Hine. Topotype. Fig. 12. *T.* (*N.*) *dorsiger* var. *longipilosus* Kröb. Matto Grosso, Brasil. Fig. 13. *T.* (*N.*) *stuppeus* n. sp. São Paulo, Brasil. Fig. 14. *T.* (*N.*) *columbus* n. sp. Rio Solimoes, Brasil. Fig. 15. *T.* (*N.*) "*truquii* Stone." Arkansas, U. S. A. Fig. 16. *T.* (*N.*) *vittiger guatemalanus* Hine. Panama.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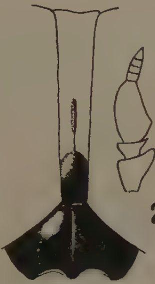
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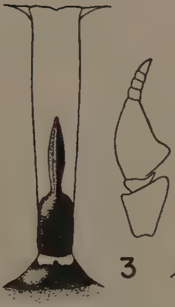
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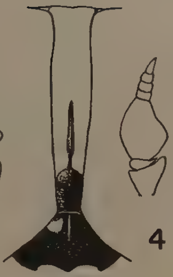
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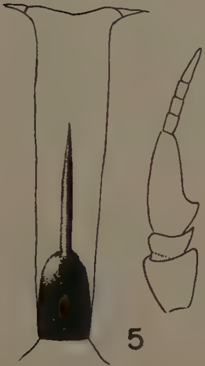
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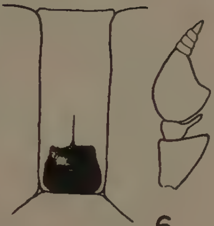
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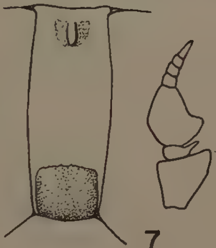
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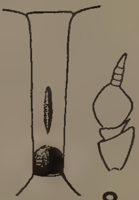
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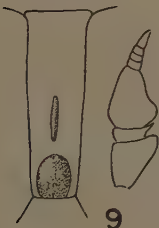
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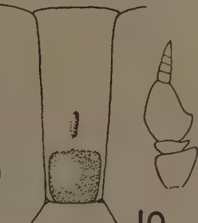
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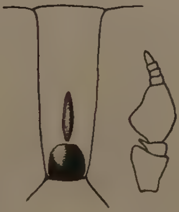
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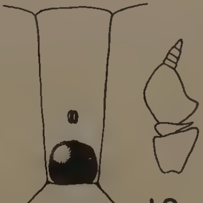
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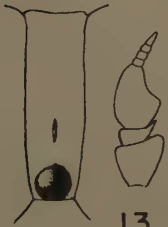
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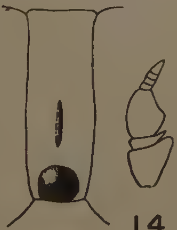
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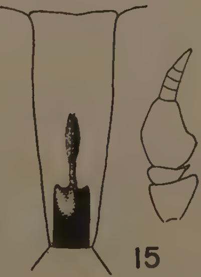
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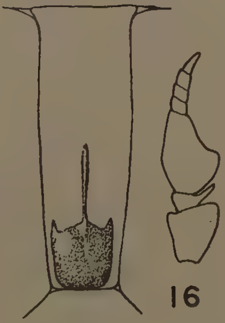
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before me. The callus is small, rounded, yellow. Thorax and abdomen nearly black, the stripes white, the median even, the laterals slightly irregular. I have seen specimens only from the type locality, Pedernales, Venezuela.

There seem to be a considerable number of small species related to *curtus* in South America, but I have no such extensive series of them as is available for the study of the *lineola* complex, in most cases only a few specimens from one or two localities. Some of these have undoubtedly been previously described, but I have been unable to associate most of the forms before me with any published descriptions. The males of most of these forms remain unknown, which makes the problem especially difficult. A key to the forms I have been able to distinguish is here given, together with short descriptions and figures. They are given specific names with much misgiving, mainly for ease of reference. The specimens will be available, and with the accumulation of more material, the problem may eventually be solved.

KEY TO FEMALES OF CURTUS GROUP

1. Fore coxae and posterior femora blackish, wholly or in part.................. 2
   Fore coxae and posterior femora wholly yellowish........................ 4
2. Only extreme bases of posterior femora dusky. First and second tergites and sternites with an integumentary black patch, otherwise yellowish brown. Stripes yellow haired, even, fairly broad. Scutellum dark....**cicur**
   Posterior femora with only the apices light.............................. 3
3. Antennal tooth obtuse, short, the basal part of third segment ½ longer than wide..**curtus**
   Antennal tooth acute, prominent, basal part of third segment about as wide as long...................................**dorsiger** var. **longipilosus**
4. Frons broad but convergent. Callus yellow, square, nearly as wide as frons. Scutellum reddish, abdominal stripes broad, white and even **despectus**
   Frons narrower. Callus round or square, but well separated from eye margins.. 5
5. Thorax brown, brown or yellowish haired. Abdominal stripes broad, even, creamy or white haired.......................................**columbus**
   Thorax brown, brown or yellowish haired. Abdominal stripes narrow, the middle one even or irregular, the laterals generally step-like.......**stuppeus**

Tabanus (Neotabanus) cicur n. sp.

Two females from Restrepo, Dept. Meta, Colombia, collected by J. Bequaert and P. C. A. Antunes. They measure just under 11 mm. In addition to the characters given in the key, the callus is black, mesonotum and scutellum blackish, brownish grey and yellow haired, wings entirely hyaline.

Tabanus (Neotabanus) dorsiger var. **longipilosus** Kröber (?)

(Pl. I, fig. 12)

Two females from Maracajú, Matto Grosso, Brasil, April–May, 1937 (Shannon and Fairchild coll.). The callus in one is reddish, black in the other. Mesonotum and scutellum blackish, grey haired. Abdomen blackish, reddish on sides. Stripes medium the median narrower than intervals, whitish, the laterals broader, even, creamy. Except for the quite even stripes, this form agrees fairly well with Kröber's (1933, p. 351) description of *T.* (*N.*) *dorsiger* var. *longipilosus*.

Tabanus (Neotabanus) despectus n. sp.

(Pl. I, fig. 10)

This is the species recorded by Bequaert (1926, p. 229), and I have seen only his specimen from Vista Alegre, Rio Branco, Amazonas, Brasil, Sept. 6, 1924. The specimen measures 10 mm.

Tabanus (Neotabanus) columbus n. sp.

(Pl. I, fig. 14)

The small callus is black or yellow, and the whole insect quite pale and grey. 1 ♀, Isla Paloma, Orinoco delta, Venezuela, Feb. 11, 1935 (N. A. Weber); 1 ♀ Caicara, Rio Solimoes, Brasil, Aug. 2, 1935 (J. Serafim); 2 ♀, ? Bahia, Brasil. Length 9–10 mm.

Tabanus stuppeus n. sp.

(Pl. I, fig. 13)

3 ♂ and 27 ♀ from various localities in the states of São Paulo, Goyaz, and Matto Grosso, Brasil. The coloration is about as in *cicur* but the coxae and femora are wholly pale. The males have bare eyes, the facets not greatly differentiated, all three abdominal stripes well marked, yellow, intervals brown haired, laterals step-like.

Tabanus (Neotabanus) dorsiger var. **pallidefemorata** Kröber (?)

Finally, I have a considerable series of females from Panama (Pl. I, fig. 9) all under 11 mm. which I am unable to separate from *lineola* var. *carneus* except by their smaller size. These may be what Kröber (1933, p. 352) calls *dorsiger* var. *pallidefemorata*, at least they agree with his description better than any other Panama material. I have also 2 males which agree well, but they are from Venezuela and Trinidad. The eyes are bare, and the facets not greatly differentiated.

Tabanus (Neotabanus) unistriatus Hine

(Pl. I, fig. 2)

Tabanus unistriatus Hine, 1906, Ohio Naturalist, VII, 2, p. 28. Kröber, 1933, Rev. Ent., III, 3, p. 365; 1934, Op. Cit., IV, 3, p. 294. Dunn, 1934, Psyche, XLI, 3, p. 174.

I have seen Hine's types, which consist of 3 females from Piedras Negras, Carillo, and San Carlos, Costa Rica (Schild coll.). There are also 3 females from Tela, Honduras, May, 1927 (Hubbel coll.) in the Hine coll. I have also seen 6 ♀ from Lancetilla, Tela, Honduras, and 1 ♀ from San Carlos, Costa Rica in Dr. Bequaert's collection.

Panama records. I have seen only a short series of the specimens taken by Dunn at Camp Pital, Chiriqui, July, 1929, and reported by him (1934).

Tabanus (Neotabanus) fumatipennis Kröber

(Pl. I, fig. 3)

Tabanus (*Neotabanus*) *fumatipennis* Kröber, 1933, Rev. Ent., III, 3, p. 341; 1934, Op. cit., IV, 3, p. 293.

Tabanus trivittatus Hine, 1906, Ohio Naturalist, VII, pp. 22, 27. (? nec. Fab. ?). Hine, 1920, Ohio Journ. Sci., XX, 6, p. 190. Bequaert, 1926, Med. Rep. Harvard Exped. Amazon, Pt. 3, p. 228.

There is a specimen in the Hine Collection labelled "*T. callosus* Macq. comp. with type," but I am inclined to accept Kröber's diagnosis in the present case. Fabricius' and Wiedemann's descriptions of *trivittatus* do not mention the bare subcallus. Bequaert (1926) gives *Tabanus primitivus* Wlk., 1848, as a synonym of this species, but Kröber (1930, Zool. Anz., LXXXVII, p. 11, fig. 10) who states that he saw the type, places Walker's species in the subgenus *Macrocormus*.

Distribution: I have seen material from the states of Amazonas and Pará, Brasil, Trinidad, British Guiana, Panama and Costa Rica.

Panama records. Cabima, May 24, 1911 (Busck coll.); Cruces Trail, Madden Highway, C. Z., July 1, 1939; Moja Pollo, May 27, June 24, 1940; Summit, C. Z., June, 1930 (Dunn); Escobal, May 4, 1931 (Dunn).

Tabanus (Neotabanus) callosus Macquart

(Pl. I, fig. 4)

Tabanus callosus Macquart, 1847, Dipt. Exot., Suppl. III, p. 11. Kröber, 1933, Rev. Ent., III, 3, p. 342; 1934, Op. cit., IV, 3, p. 292 (*Neotabanus*).

Tabanus sp. No. 1. Bequaert, 1926, Med. Rep. Harvard Exped. Amazon, Pt. 3, p. 229, fig. 7g. (Rio Branco, Amazonas.)

Kröber claims to have seen the type. Hine's specimen which he compared with the type is *fumatipennis* Kröber. The species is very like *fumatipennis*, but the wings are entirely hyaline, and the structure of frons and antennae is quite different.

Distribution: Specimens are before me from San Alberto, Rio Branco, Amazonas, Aug. 25, 1924 (J. Bequaert), and Marajó Is., Pará, Brasil (R. Damasceno). Kröber records it from Surinam also.

Tabanus (Neotabanus) lucidecallosus sp. nov.

(Pl. I, fig. 1)

Female—Length 11 mm., of wing, 9 mm. Eyes bare, green with two purple bands and the margins purple. Frons yellowish grey, about eight times as high as basal width, and more than twice as wide at vertex as at base. Frontal callus higher than wide, brown. Subcallus shiny, yellow, not greatly inflated. The figure shows the subcallus black, but this is an error. Antennae orange, the annulate portion a little darker. Palpi white, sparsely black haired.

Mesonotum dark grey, vestiture of dark grey and shiny brassy hairs forming indistinct stripes. Scutellum concolorous. Pleura and sternum grey, with pale hairs. Coxae, all of fore femora, and basal two-thirds of mid and hind femora blackish. Fore tibiae bicolored, mid and hind tibiae and apices of femora yellow, tarsi blackish. Wings entirely hyaline; stigma narrow, yellow; no appendix on third vein.

Abdomen orange brown, blackish in the middle. Stripes even, median brassy haired, the intervals black haired. Venter orange brown, dusky along the mid-line, grey pollinose and whitish haired.

Holotype ♀, Maracajú, Matto Grosso, Brasil, April–May, 1937 (Shannon and Fairchild); Paratypes: 1 ♀, same date; 1 ♀ Cerro Pelado, Paraguay (F. Schade); 1 ♀ Villarica, Paraguay (F. Schade). To be deposited in the M. C. Z. Harvard University, Cambridge, Mass. There is also a specimen in the Hine Coll. from San Bernadino, Paraguay (Fiebrig coll.) which appears to be the same. This species differs conspicuously from *callosus* Macq. and *fumatipennis* Kröb. in the much lighter color, even, continuous abdominal stripes and much more convergent frons. Kröber's var. *brunniventris* seems to differ in having irregular lateral stripes and a different eye pattern, and seems to be correctly placed as a light form of *callosus*.

Tabanus (Neotabanus) restrepoensis sp. nov.

Female—Length 10 mm., of wing, 9 mm. Very close to *lucidecallosus*, of which it may be a local race, but differing in the following respects. Frons about seven times as high as basal width, vertex hardly one and one-half times as wide as base. Palpi less inflated basally. Mesonotum without indication of stripes. Coxae and femora wholly pale yellowish. Abdomen wholly yellow, the stripes broader, yellow haired. Otherwise as in *lucidecallosus*.

Holotype ♀ and 5 ♀ Paratypes, Restrepo, Dept. Meta, Colombia (J. Bequaert coll.). To be deposited in the M. C. Z., Harvard University, Cambridge, Mass.

Tabanus (Neotabanus) hookeri Knab

Tabanus hookeri Knab, 1915, Ins. Ins. Mens., III, 1–4, pp. 48–49 (♂, ♀; Mayaguez, Puerto Rico).
Tabanus filiolus Johnson, 1919, Bull. Amer. Mus. Nat. Hist., XLI, p. 428. Not *T. filiolus* Will. 1901.
Tabanus flavifrons Szilady, 1926, Biol. Hung., I, pt. 7, p. 22, Pl. 4, fig. 12 (♂, ♀; Cuba).
?*Tabanus refiventris* Macquart, 1838, Mem. Soc. Sci. Lille, pt. 2, p. 145 (♂; Cuba). Not *T. rufiventris* Fab. 1805, not *T. rufiventris* Macq. 1845.
Tabanus (*Neotabanus*) *hookeri* Bequaert, 1940, Rev. Ent., XI, 1–2, pp. 361–365, fig. 32. (Cuba, Jamaica, Puerto Rico, Hispaniola, Barbados, Venezuela, British Guiana, Colombia, Trinidad, Brazil, Paraguay and Argentina.)

Bequaert (l. c.) has given a thorough discussion, excellent figures, and complete synonymy of this species, which there seems no need to repeat here. The bare subcallus and broad frons will easily separate it from other members of the group. The complete absence of such a wide ranging species from Central America is very curious.

Tabanus (Neotabanus) johannesi sp. nov.

(Pl. I, fig. 6)

Female—Length 11 mm., of wing, 9 mm. Eyes bare under a hand lens, but showing sparse and very short pubescence under magnification of 32 diameters. Eyes (revived) green, the upper and lower margins purple, and with a complete median and incomplete upper purple band. Frons a little less than three times as high as wide, parallel sided, dark grey pollinose. Frontal callus black, nearly as wide as frons and wider than high. Subcallus, fronto-clypeus and genae pale grey pollinose, beard white. Palpi white, sparsely black haired. Antennae as figured, the basal segments pale yellowish, black haired, the third segment orange.

Mesonotum blackish, the vestiture black and grey, forming indistinct stripes. Scutellum black. Pleura and sternum dark grey, white haired. Coxae, all femora except extreme apices, all tarsi, and apical half of fore tibiae black. Basal half of fore tibiae white, other tibiae and apices of femora dirty yellowish. Wings entirely hyaline, stigma pale yellow.

Abdomen black above, with an even, slender, white mid-dorsal line from first to sixth tergites. Lateral stripes white, extending to sixth tergite, and formed of oblique oval patches which do not overlap. Venter black, sparsely white haired, especially on the posterior sternal margins.

Male—Eyes contiguous, pubescent, especially on the large facets. Facets but slightly differentiated in size, the larger occupying about half total eye area and poorly demarkated from the smaller. Coloration essentially as in female, but tibiae rather brownish, including basal half of fore pair. Antennae more slender, but still unusually broad for a male of this group.

Holotype ♀, Villarica, Paraguay (F. Schade coll.). To be deposited in the M. C. Z., Harvard University, Cambridge, Mass. Allotype ♂, Severinia, São Paulo, Brasil, Dec., 1940 (A. G. Silva coll.). In the collection of the Instituto de Hygiene, São Paulo, Brasil. 1 ♀ Paratype, Agua Limpia, Brasil, March 27, 1925, in Coll. J. Bequaert.

I had at first considered this species to be *pungens* Wied., but the description of the latter states that the abdomen has the mid-stripe of broad triangular spots, and the wing veins and costal cell (Randmal) brownish. The species seems rather closely related to *hookeri* and *angustivitta* of this paper.

Tabanus (Neotabanus) angustivitta Kröber

(Pl. I, fig. 7)

Tabanus (*Neotabanus*) *dorsiger* var. *angustivitta* Kröber, 1929, Ann. Naturh. Mus. Wien, XLIII, p. 250, fig. 9. (♀; Taperinha, near Santarem, Brazil); 1933, Rev. Ent., III, 3, p. 352 (redescribed as new!); 1934, Rev. Ent., IV, 3, p. 293.

I have used Kröber's name for this species, as his description conforms the most closely to my material, but it is very probable that an earlier name for the species exists, though I have been unable to find one which entirely fits. *Pungens* Wied. 1828, is the oldest name, but Kröber, who had seen the type, places it in *Agelanius* in his catalogue (1934, p. 302). I have not seen the original description of *desertus* Walk., 1850, but the figure given by Bodkin and Cleare (1916, p. 186) certainly resembles the present form closely. Kröber did not recognize the species. Two of Bellardi's descriptions are close, but *subsimilis*, 1859, seems to have a bare subcallus and blackish femora, while *propinquus* 1859, is stated to have the vestiture yellowish. *Furunculus* Will., 1901, reads much like the present species also, but the description is not sufficiently detailed for certainty.

Distribution: In the Hine collection there is a male from Tabasco, Mexico, and a number of females from Morales and Panzos, Guatemala, labelled *sallei* Bell., and a single female (Georgetown, Brit. Guiana, Cleare coll.) labelled *comitans* Wied. I have also seen specimens from Venezuela (Caripito, July, 1937); Isla do Marajó, Pará, Brasil; and São Paulo, Brasil (Juquia, Oct. and Dec., J. Lane); Bahia, Brasil; Mendoza, Argentina; Restrepo, Colombia; Guayaquil, Ecuador; Villarica, Paraguay, and Lima, Peru.

Panama records: One of the more abundant species throughout the Republic. Moja Pollo, practically throughout the year, but less abundant in Sept. and Oct.; Darien (Dunn); El Valle, Coclé Prov., Dec., 1939; Mt. Hope, C. Z., Nov., 1939; also bred from larvae on several occasions.

Tabanus dunni n. sp.

(Pl. II, fig. 18)

Female—Length 13–14 mm., of wing, 11–12 mm. Eyes bare, the color pattern (revived) consisting of a pair of median green stripes, the upper of which is broad and invaded by a purple spur from the frontal margin. The background is purple. Frons dark grey pollinose, with a darker patch at vertex, and covered with moderately dense dark hairs, between 3½ and 4 times as high as basal width, very slightly wider at vertex than at base. Basal callus somewhat higher than wide, rounded, oval, brown, about half the width of the frons, and produced above in a fine line about one-third the distance to the vertex. Subcallus yellowish grey pollinose. Antennae dirty yellowish brown, the first segment lighter, the annulate portion darker. First segment inflated, beset with black hairs which are densest on the dorsal projection. Second segment scale-like, the dorsal tooth moderate and beset with black hairs. Third segment with a prominent dorsal angle and bowed ventrally, the basal part considerably wider than the first segment, but not as wide as long. The length of the annulate portion is to that of the basal portion as 3 to 4. Clypeus and genae light grey pollinose, the former with sparse pale hairs, the latter with long white hairs. Palpi strongly inflated basally, slender apically, dusty grey and with numerous black hairs, about as long as antennae. Proboscis dark brown, a little longer than palpi, the labella about half the length of the proboscis.

Mesonotum dark grey, rather thickly clothed with black and pale silvery hairs. The silvery hairs form a narrow mid-dorsal stripe, two dorso-lateral stripes, and a rather wide lateral border to the mesonotum. Prescutal lobe reddish, with black hairs. Scutellum concolorous with mesonotum, dark haired on the disk, light haired around the margin. Pleura and sternum dark grey pollinose with rather abundant pale hairs.

Wings completely hyaline, the stigma very pale straw colored, all cells but the anal widely open, no appendix on 3rd vein. Femora and coxae dark greyish, mostly with pale hairs, tibiae dusky yellowish with dark hairs on the outer surfaces, pale hairs on the inner. Fore tibiae darker apically, and with pale hairs on the proximal third. Tarsi dirty brownish.

Abdomen uniformly dull black or somewhat reddish on the sides of the first two or three tergites, covered with dense short hairs of black and silvery color, the silvery hairs forming a prominent mid-dorsal contiguous row of triangular spots, a dorso-lateral series of oval or oblong non-contiguous, parallel sided spots on the first to fifth tergites on each side, and narrow lateral margins to tergites one to six. Beneath the abdomen is dark slate grey, sometimes pinkish on the first few sternites, with narrow lighter hind margins and clothed with grey pollinosity and sparse pale hairs.

Holotype ♀ and 3 ♀ Paratypes from Miraflores, C. Z., Jan. 10, 1930, (L. H. Dunn collector). 1 ♀ Paratype from Ancon, C. Z., (L. H. Dunn collector). Holotype and 2 Paratypes to be deposited in the M. C. Z., Harvard University, Cambridge, Mass. 1 Paratype in the U. S. N. M.

This species is similar to *amplifrons* on the one hand, from which it differs in largely black legs and irregular stripes, and to *maya* on the other, from which it differs in wholly black color, prominently striped thorax, whitish vestiture, and by the lateral stripes not being at all oblique.

Tabanus (Neotabanus) lineola Fab.

Under this name I include an abundant, widespread and polymorphic species, which in various forms and under a multitude of names, appears to range from Canada to the Argentine Republic. Although I have examined a good many hundreds of specimens from Southern Brasil, Panama and the United States, and a smaller number of specimens from perhaps 30 additional localities, I have seen practically no material from Mexico, from the area lying between Bahia and the mouth of the Amazon, from Western South America south of Colombia, or from Uruguay and Argentina. The lack of Mexican material is especially unfortunate, as it is there that the Neotropical and Nearctic forms would be expected to meet. The present arrangement of the various forms is thus in no sense to be taken as final.

In regard to the use of the terms "form," "variety" and "subspecies," perhaps a word of explanation is necessary. I regard subspecies as populations which are geographically separated from other similar populations, and which show morphological differences from those populations, but which freely interbreed, or are assumed to be able to interbreed, with the formation of morphologically intermediate forms, where their ranges overlap. This is essentially the definition of Bates (1935), but while he uses the term "Choromorph" as being more precise, "subspecies" seems now well established in many branches of zoology for this taxonomic concept. It follows from the above that two subspecies of the same species cannot occupy the same geographic area in toto. There may, of course, be a fairly wide band of territory where their ranges overlap, or the barriers which kept them spearate may have been removed sufficiently recently so that interbreeding has not had time to erase their morphological differences, but such cases must form a rather rare exception. For the morphologically distinct forms found occupying the same area, the choice must be made between considering the form a full species, or a "variety." I regard a variety as a morphologically distinct form found occupying the same range as the species, and showing all degrees of intermediacy with it.

In dealing with the present complex, many difficulties have arisen in applying these two definitions to specific cases. Lack of material from critical areas has made it difficult to define the ranges of the various forms, and forms which seem worthy of specific rank in one area, intergrade completely in another. For these reasons, I have concluded that it is best to treat all the forms as varieties for the present. Although a variety has no nomenclatorial standing, most of the names used here were proposed as specific names, and hence are available should later revision necessitate their return to subspecific or specific rank.

The problem of assigning a name to a given specimen of this group, especially a female, is exceedingly difficult, as the various varieties often intergrade completely, while some varieties are difficult to distinguish from closely allied species. The species as a whole may be characterized as follows:

Eyes bare in both sexes, those of the male with the two types of facets very little or very greatly differentiated in size. Frons from four to seven times as high as wide, nearly always widest at vertex, sometimes widest in the middle. Frontal callus square, rounded, or somewhat higher than wide, yellow to black. Coloration exceedingly variable, ranging from pale yellowish brown to nearly black. Vestiture of the thorax yellow, grey, unicolorous or obscurely striped, often with irridescent scale-like hairs. Legs variable, wholly yellow to nearly all black, but the fore tibiae always bicolored. Abdomen always three-striped, but the lateral stripes sometimes faint or reduced. Stripes white or yellow, broad or narrow, even or irregular.

The various varieties may be separated by the aid of the following keys, except that there will always be a residuum of specimens of intermediate character.

KEY TO MALES

1. Enlarged facets of eye very much larger than small facets, and occupying at least ⅔ of eye area, the line of demarkation between the two types very abrupt 2
   Enlarged facets of eye at most only two or three times as large as small facets, and occupying only about ½ eye area, the line of demarkation between the two types not very clearly defined 3
2. Fore coxae and mid and hind femora wholly yellow. Thorax yellowish brown pollinose, yellowish haired, unstriped. Scutellum, at least apex, yellowish red. Abdomen yellowish brown; no dark on first or second tergites. Median stripe broad, parallel sided, yellow haired. Lateral stripes narrow, obsolescent, yellow haired. Between the stripes the vestiture is orange brown, with a few black hairs on the terminal segments. Venter immaculate, yellow . . . . var. **carneus**
   Fore coxae and bases of mid and hind femora at least ⅓ blackish. Thorax grey pollinose, whitish haired, rather faintly dark striped. Scutellum dark. Abdomen yellowish to brown, with a more or less well defined blackish patch beneath the scutellum and on the middle of the second tergite. Median stripe broad, parallel sided, white haired. Lateral stripes well defined, either parallel sided or slightly irregular, white or creamy haired. The abdomen is mostly black haired between the stripes. Venter pale yellowish or brownish, with occasionally a dark median patch or patches on the anterior sternites, and the terminal sternite black . . . . var. **lineola**
3. Fore coxae and at least basal third of mid and hind femora black 4
   Fore coxae yellowish, the mid and hind femora at most slightly dusky at base 5
4. Thorax blackish, brown to yellowish pollinose, and with an unusual number of irridescent scale-like hairs mixed with the vestiture. Abdomen yellowish brown, the rather prominent, parallel sided stripes rich yellow haired, the intervals between them black haired. First and second sternites with a prominent black median patch, and terminal sternites black, otherwise venter clear yellow. Wings markedly smoky, var. **stenocephalus**
   As above, but whole insect darker, nearly black, the abdominal stripes pure white to somewhat creamy, the legs extensively black, the venter with a broad mid-ventral black band . . . . var. **plangens**
5. Median abdominal stripe very narrow. Abdomen brownish, with a black spot on first two tergites. Lateral stripes faint, broken up into spots. Stripes yellowish white haired, intervals blackish. Thorax blackish or dark grey, rather prominently striped. Scutellum reddish. Venter pale, with a more or less distinct dark patch on first two sternites, var. **scutellaris**
   Median abdominal stripe rather broad; lateral stripes prominent, continuous. Abdomen all yellow, light brown haired, the stripes pale yellow haired. Thorax grey, with yellowish grey tomentum and hairs, unstriped. Scutellum concolorous or slightly lighter than thorax. Venter pale, with or without a small dark spot at base . . . . var. **ochrophilus**

KEY TO FEMALES

1. Fore coxae and mid and hind femora pale or yellowish, never more than a slight infuscation at base. Scutellum reddish, yellowish or concolorous with mesonotum 2
   Fore coxae and mid and hind femora at least ⅓ black at base. Scutellum always concolorous with mesonotum 3
2. Wings always hyaline. Ground color pale brown to black. Frons rather broad, with a large square basal callus, and generally rather large oval median callus. Mesonotum obscurely striped. Scutellum reddish apically. Median abdominal stripe white, generally somewhat irregular. Lateral stripes often creamy, usually irregular and step-like. . . var. **scutellaris**

Wings often smoky, or the veins brown margined. Ground color yellow to brown. Frons rather narrow, convergent, the basal callus small, rounded, the median callus slender or absent. Mesonotum unstriped. Scutellum concolorous with mesonotum, or reddish or yellowish, wholly or in part. Median stripe yellow or white, generally quite broad and even. Lateral stripes variable........................var. **carneus;** var. **ochrophilus**

3. Wings always entirely hyaline. Body color pale brown to black, the stripes white, greyish, or creamy, often irregular. Frons rather narrow to broad, convergent......................................var. **lineola**

Wings always somewhat smoky, the veins generally narrowly brown margined.. 4

4. Whole insect black or predominantly blackish, the lighter pollinosity mostly greyish. Legs extensively blackish. Stripes white or greyish..var. **plangens**

Whole insect predominantly yellow, the lighter pollinosity yellowish. Legs extensively yellow. Stripes rich yellow, the intervals black haired, var. **stenocephalus**

In regard to the names used for the various varieties, I have endeavored to list under each variety the names which seem definitely to refer to that form. Names preceded by a query, I consider probably to refer to the form in question. By using *lineola* Fab. 1794 for the whole complex and treating the various forms as varieties, all other names except *occidentalis* Linn. 1767, which may have been used for a member of this complex, become synonyms; and since varieties have no nomenclatorial standing, I have felt free to choose names on the basis of the availability of types or completeness of description, without regard to priority. In regard to *occidentalis* Linn. considerable confusion seems to exist. The original description is quite inadequate. Kröber (1933, p. 359) refers to a male in the Vienna Museum as type, with a query. This was probably one of the specimens used by Wiedemann, as it bears a label in his handwriting, according to Kröber. It may or may not have been the same as Linnaeus' species, but was almost certainly not his type. In the Hine collection there is a female from

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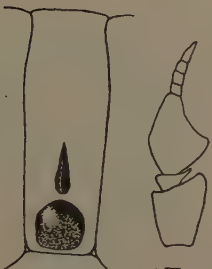
EXPLANATION OF FIGURES

(Also see page 158)

PLATE II

Fig. 17. *T.* (*N.*) *amplifrons* Kröb. Panama. Fig. 18. *T.* (*N.*) *dunni* sp. nov. Holotype. Fig. 19. *T.* (*N.*) *maya* Beq. Panama. Fig. 20. *T.* (*N.*) *triangulum* Wied. São Paulo, Brasil. Fig. 21. *T.* (*N.*) *lineola* var. *carneus* Bell. Moja Pollo, Panama. Fig. 22. *T.* (*N.*) *lineola* var. *carneus* Bell. Matto Grosso, Brasil. Fig. 23. *T.* (*N.*) *lineola* var. *carneus* Bell. Mt. Hope, C. Z., Panama. Fig. 24. *T.* (*N.*) *lineola* var. *carneus* Bell. Mt. Hope, C. Z., Panama. Fig. 25. *T.* (*N.*) *lineola* var. *carneus* Bell. (grey form). Moja Pollo, Panama. Fig. 26. *T.* (*N.*) *lineola* var. *stenocephalus* Hine. Moja Pollo, Panama. Fig. 27. *T.* (*N.*) *lineola* var. *scutellaris* Wlk. Wyoming, U. S. A. Fig. 28. *T.* (*N.*) *lineola* Fab., typical form. Arkansas, U. S. A. Fig. 29. *T.* (*N.*) *lineola* Fab., typical form. Rochester, N. Y., U. S. A. Fig. 30. *T.* (*N.*) *lineola* Fab., gulf coast form. Munroe Co., Florida, U. S. A.



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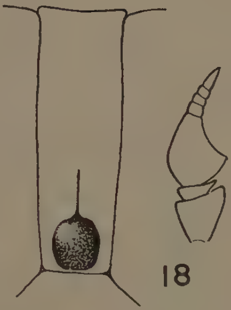

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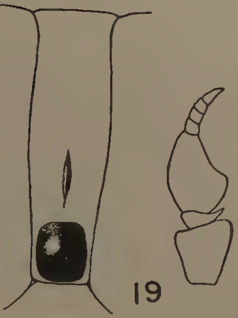

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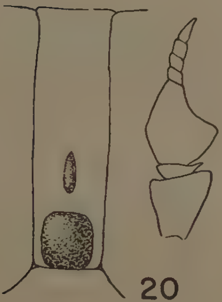

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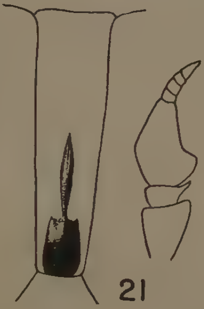

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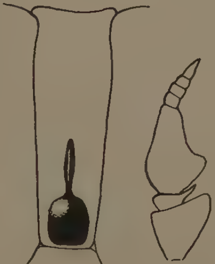

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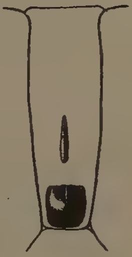

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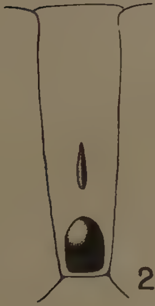

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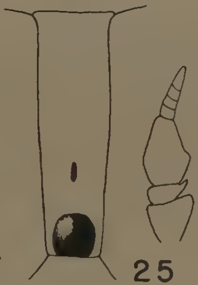

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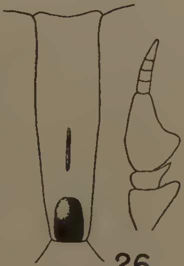

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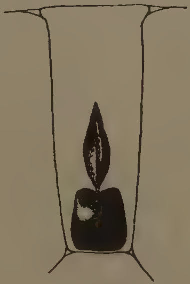

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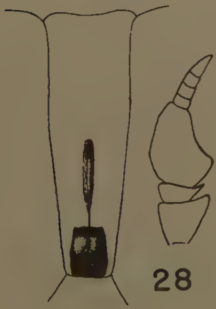

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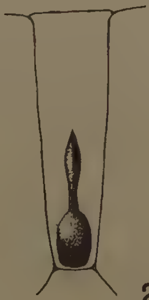

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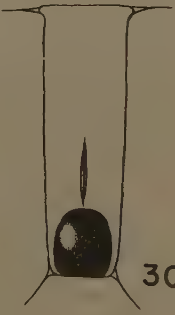

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South America bearing a label, "occidentalis ? comp. at B. M." and a yellow "Comp. with type" label, which is the same as *carneus* or *ochrophilus* of the present paper. The *occidentalis* of Wiedemann (1828) and Kröber, who followed him, seems definitely to have been *stenocephalus* of the present paper. Kröber placed *stenocephalus* Hine as a "species dubia." If Hine's specimen was really conspecific with the specimen he saw at the British Museum, and the latter was really Linnaeus' type, then *occidentalis* becomes the correct name for the species. However, *lineola* is now well established in the literature, and Fabricius' type, or what remains of it, has been examined by recent students, so there seems to be no useful purpose served by reverting to the older name.

Tabanus (**Neotabanus**) **lineola** Fabricius, typical form

(Pl. II, figs. 28, 29, 30)

Tabanus lineola Fabricius, 1794, Ent. Syst., V, 4, p. 369.—(♀; America Boreali.)
Stone, 1938, U. S. Dept. Agric. Misc. Publ. No. 305, p. 122, fig. 57A. (♂, ♀; Maine to Florida, Westward to Texas.)

This and the following variety will be discussed in a forthcoming paper by Dr. C. B. Philip, to whom I owe the loan of much valuable material and innumerable helpful suggestions and criticisms. I am not in a position to allocate the various references to "lineola" to their proper varieties, and will leave that to Dr. Philip. This variety appears to range over most of Eastern North America as far west as eastern Texas. Specimens from the Gulf coast of Louisiana have the stripes exceedingly broad and pale, and the frons as broad as in *scutellaris*, but are connected by a series of intergrades to the typical form. This local variant is what Hine called *T. quinquevittatus* Wied. (1906, Ohio Naturalist, VII, p. 26).

Tabanus (**Neotabanus**) **lineola** var. **scutellaris** Walker

(Pl. II, fig. 27)

Tabanus scutellaris Walker 1850, Insect. Saunders., Dipt., V, 1, p. 27. (♀; Bolton, North America.)
Tabanus lineola var. *scutellaris* Stone, 1938, U. S. Dept. Agric. Misc. Publ. No. 305, p. 123. (British Columbia to Massachusetts, south to Arizona and Georgia.)

This form occurs with the typical form throughout most of its range, but replaces it almost entirely in the western part of North America. The typical form is said to be more common along the coast, the present form dominant inland. Specimens from the southwest are very pale, with broad stripes, but this appears to be but a variant perhaps due to environmental factors.

Tabanus (Neotabanus) lineola var. **carneus**

(Pl. II, figs. 21–25)

Tabanus carneus Bellardi, 1859, Ditt. Mess., I, p. 62. Hine, 1906, Ohio Naturalist, VII, 2, pp. 21, 23; 1925, Occ. Pap. Mus. Zool., Univ. Michigan, No. 162, p. 53. Kröber, 1933, Rev. Ent., III, 3, pp. 340, 341, 355; 1934, Op. cit., IV, 3, p. 292. Bequaert, 1940, Bull. Ent. Res., XXX, pt. 4, pp. 451, 453.

Tabanus appendiculatus Hine, 1906, Ohio Naturalist, VII, 2, p. 22. Bequaert, 1926, Med. Rep. Harvard Exp. Amazons, Pt. II, p. 227. Kröber, 1933, Rev. Ent., III, 3, p. 357.

Tabanus (Neotabanus) carneus var. *appendiculatus* Kröber, 1934, Rev. Ent., IV, 3, p. 292.

Tabanus trillineatus Bequaert, 1926, Med. Rep. Harvard Exped. Amazons, Pt. II, pp. 227, 228. Hine, 1906, Ohio Naturalist, VII, 2, pp. 21, 27.

Tabanus truquii Kröber (nec. Bell., nec. Hine, nec. Stone), 1929. Ann. Naturhist. Mus., Wein, XLIII, p. 248 (the white striped variety).

?*Tabanus fur* Williston, 1901, Biol. Cent. Amer., Dipt., I, Suppl., p. 261. (nec. *T. fur* Will., 1887.)

?*Atylotus eutaeniatus* Bigot, 1892, Mem. Soc. Zool. France, V, p. 664 (♂; Brasil). Kröber, 1933, Rev. Ent., III, 3, p. 357. (Type seen, no other specimens.)

?*Tabanus dorsovittatus* Macq., 1855, Dipt. Exot., Suppl. V, p. 30 (♀; South America). Kröber, 1933, Rev. Ent., III, 3, p. 356. (Type seen.)

?*Tabanus (Neotabanus) dorsiger* var. *pallidefemorata* Kröber, 1929, Ann. Naturhist. Mus. Wein, XLIII, p. 249 (♂, ♀; Amazonas); 1933, Rev. Ent., III, 3, p. 352 (Amazonas, Peru, Honduras, Canal Zone).

?*Tabanus consequa* Walker, 1850, Newm. Zool., VIII, Appendix, p. 121; 1854, List. Dipt. Brit. Mus., V, p. 213. Kröber, 1933, Rev. Ent., III, 3, p. 353 (♀; Brasil. Type seen.)

The color of the thorax varies from strongly yellowish brown to pale steel grey, and of the abdomen from honey yellow to nearly black. The abdominal stripes may be yellow or practically white. The size is also quite variable, some specimens being less than 9 mm. long while extra large examples may reach 15 mm. Kröber's (1933) description of his *dorsiger* var. *pallidefemorata* may have been based, at least in part, on such small specimens.

I have examined Hine's types of *appendiculatus* in Columbus, Ohio, which consist of 7 ♀ from various localities in Guatemala, and 1 ♂ from Belize, Br. Honduras. They seem to represent a darker segregate with rather whitish stripes. There are also specimens of the variety here called *carneus*, labelled as *subsenex* Walk., *trilineatus* Latr., and *eutaenius* Bigot by Hine. *Tabanus truquii* Kröber, 1929, seems also to have been based on the whitish striped form of this variety. *T. fur* Williston may or may not be the same, the striped thorax would suggest some other species. Hine (1925, p. 33) suggested the synonymy, and at any rate there is an earlier *T. fur.* of Williston.

Distribution: I have seen specimens from Guatemala, British Honduras, Panama, Colombia, Venezuela, Surinam, Trinidad, Peru, Paraguay and the states of Pará, Bahia, Goyaz, Rio de Janeiro, São Paulo and Matto Grosso in Brasil. The variety was described from Mexico, and Kröber reports it also from Costa Rica and Ecuador.

Panama records: The form is abundant throughout the Republic, flying at all seasons of the year. At one locality, Moja Pollo on the Chagres River above Gamboa, where collections on horse bait have been made every two weeks for the past year, over 5600 specimens have been taken, about 49% of all *Tabanidae* collected at this station.

Tabanus (Neotabanus) lineola var. **plangens** (Walker)

Tabanus plangens Walker, 1854, List. Dipt. Brit. Mus., V, p. 199. Kröber, 1933, Rev. Ent., III, 3, p. 347.

?*Tabanus modestus* Wiedemann, 1828, Auss. Zweifl. Insect., I, p. 146. Hine, 1906, Ohio Naturalist, VII, 2, pp. 22, 25.

I have seen no males of this form, but from Kröber's description I gather that the eye is like *stenocephalus*. The frons and antennae of the female are also as in *stenocephalus*. In Central America it seems to be rather uncommon, but in Southern Brazil it is quite abundant. There is also what I consider to be a dark form of *triangulum* in Southern Brazil, and the two are very close in appearance. *Plangens* may be distinguished by the callus being oblong, or higher than wide, and the lateral abdominal stripes being parallel sided or slightly irregular, while in *triangulum* the callus is rounded or square, and the lateral stripes a series of markedly oblique spots.

The description of *T. modestus* Wiedemann fits the present form quite well, and the synonymy has been often suggested. Kröber (1933), however, says that the types are apparently lost. He compared material with Walker's type of *plangens*. What Lutz (1928, Pl. 9, fig. 12) calls *modestus* looks more like the dark form of *triangulum* to me. In the Hine collection there is a female from São Paulo, Brazil, det. Lutz, which is labelled *modestus*, and this agrees with what I call *plangens*. Also in the Hine collection are 2 females, both labelled "plangens Wlk." and "comp. with type." One of these (Pto. Cortez, Honduras II–23–06) is *carneus* Bell. of the present paper, the other (Atrato Valley, Colombia) agrees with the present interpretation of *plangens* Wlk. Bequaert (1926) recognized both names as applying to distinct species. His *modestus* seems to fit the present species best.

Distribution: I have seen material from Honduras, Panama, Colombia and the Brazilian states of Bahia, Goyaz, Rio de Janeiro, São Paulo, Paraná and Matto Grosso. Kröber records it in addition from Costa Rica, Peru, Paraguay, and Bequaert from Amazonas and Pará. Walker's type was from Pará.

Panama records: Darien (Dunn); Juan Mina Station, Rio Chagres, Jan. 3, 1939; El Valle, Coclé Prov., Dec. 17, 1939, June 30, 1940; Fort Randolph, C. Z., Jan. 23, 1929 (Curran); Rio Pequeni Police Sta., May 11, 1940.

Tabanus (Neotabanus) lineola var. **stenocephalus** (Hine)

(Pl. II, fig. 26)

Tabanus stenocephalus Hine, 1906, Ohio Naturalist, VII, 2, p. 27. (♂, ♀; Puerto Barrios, Morales, and Panzos, Guatemala.)

I have examined the types of this form in the Hine collection at Columbus, Ohio. They consist of 4 ♀ and 2 ♂ Cotypes, so labelled, and 2 ♀, 4 ♂ additional specimens, probably also types, all from various localities in Guatemala, taken in 1905. Kröber's *occidentalis* (1933) probably includes this variety, as he mentions specimens from Yucatan and Costa Rica. In Central America this form is quite distinct, and I have seen no specimens showing intergrades to *carneus*, but in Southern Brazil the situation is very different. There both small and large facetted males occur, and the females show every intergrade between those with entirely light coxae and femora, and those with dark coxae and the femora dark at base. The small facetted males before me, from Brazil (São Paulo), have the fore coxae dark, the femora ½ black at base and a dark patch on the first 2 sternites, while of 5 large facetted males, 2 have the coxae and femora entirely yellow, 2 have the femora slightly dusky at base, and 1 has the femora extensively dark. All have a blackish spot on the first and second sternites. The large facetted, dark legged males agree well with *eutaeniatus* Big.

Distribution: I have seen specimens from Guatemala, British Honduras and Panama. Kröber (1933) records it (as *occidentalis*) from Yucatan and Costa Rica.

Panama records: Moja Pollo, Chagres River region, March to January (probably throughout the year); El Real, Darien, Feb. 7, 1940, and Aug. 15, 1930 (Dunn); Ft. Randolph, C. Z. Feb. 11, 1930 (Dunn).

Tabanus (Neotabanus) lineola var. **ochrophilus** (Ad. Lutz)

Neotabanus ochrophilus Lutz, 1914, Mem. Inst. Osw. Cruz, VI, 1, p. 49; 1928, Est. Zool. Parasit. Venezolanas, p. 56, Pl. IX, fig. 10.

This variety is only distinguishable in the male sex, being a pale legged form with small facetted eyes. As noted under *stenocephalus*, the four tropical American forms all occur in Southern Brazil, and seem there to intergrade perfectly with one another. My identification of the male is based on a specimen from Manguinhos, Rio de Janeiro, det. Lutz, in the Hine collection. The female of the pair, same data, is indistinguishable from *carneus*. I have also a male from Petropolis, Rio de Janeiro, which agrees, except that the hind femora are slightly dusky at base. Lutz' figure (1928) is poor, and probably misled Bequaert (1940), Bull, Ent. Res., XXX, 4, pp. 451, 452). It might be best to drop the name altogether, but I prefer to retain it until the relationships of the South American forms can be better worked out.

Distribution: I have seen males only from Southern Brazil (States of Rio de Janeiro and São Paulo).

Tabanus (Neotabanus) maya J. Bequaert

(Pl. II, fig. 19)

Tabanus maya J. Bequaert, 1932, Jour. New York Ent. Soc., XXXIX, (1931), p. 546, fig. 2 (♀; Chichen Itza, Yucatan, Mexico).

Tabanus (*Tabanus*) *maya* Kröber, 1934, Rev. Ent., IV, 3, p. 311. (No material seen.)

Material in the Hine collection from localities in Mexico and Guatemala is labelled *subsimilis* Bell., and the description fits fairly well, except for the phrases "ad radican antennarum subcastanea" which would seem to indicate a bare subcallus, and "scutello ad basim cinerascente, ad marginem carneo" which is not true of the present species.

A male specimen before me from Pacora, R. de P., March 26, 1939, (Allotype), is easily associated with the female on color characters. The abdomen is largely yellowish, the lateral stripes not so pronounced as in the female, and there is a prominent black triangular spot on the first two tergites. Eye holoptic, bare, the large facets not much larger than the small, and not sharply demarkated from them.

Distribution: Southern Mexico to Panama.

Panama records: Juan Mina and Moja Pollo, Chagres River region, December to July, most abundant from April to June; Miraflores, C. Z., Jan., 1930 (Dunn). Apparently rather local.

Tabanus (Neotabanus) triangulum Wied.

(Pl. II, fig. 20)

Tabanus triangulum Wied., 1828, Auss. Zweifl. Ins., I, p. 143 (♀; Brasil).

Tabanus (*Neotabanus*) *lineola* Kröber, 1933, Rev. Ent., III, 3, p. 344 (nec. *T. lineola* Fab., 1794).

?*Tabanus* (*Neotabanus*) *uruguayensis* Kröber, 1933, Rev. Ent., III, 3, p. 346 (nec. *T. uruguayensis* Arribalzaga, 1882).

?*Tabanus* (*Neotabanus*) *uruguayanus* Kröber, 1934, Rev. Ent., IV, 3, p. 294.

Wiedemann's description fits the present species, especially since he states his specimen was much rubbed, which would bring into prominence the black triangular mark on the first two abdominal tergites. Kröber (1933, p. 361) was unable to locate the type, and did not recognize the species. Lutz used the name a number of times in lists, but with no descriptions, and I have not seen this species determined by him. I have, however, a specimen determined by Dr. Oliveria Castro, who collaborated with Lutz, and had access to his collection, so that it is probable that his references were to the present species.

Kröber's descriptions of *lineola* and *uruguayanus* apply almost equally well to my material, except that *uruguayanus* is said to have the mid-dorsal stripe of a series of triangles. This is true of a few of my specimens, but they differ in no other way from those with a uniform mid-dorsal stripe. Both the color of the abdomen and the width of the abdominal stripes are very variable, very narrow to quite broad. The lateral stripes show a tendency to be markedly step-like, but in some specimens they are nearly parallel sided.

Distribution: I have seen material from the Brazilian states of Goyaz, Rio de Janeiro, São Paulo, Paraná and Matto Grosso, and from Paraguay. Kröber lists Uruguay, Peru, Bolivia and Argentina in addition.

Tabanus (Neotabanus) strigimaculus sp. nov.

(Pl. I, fig. 5)

Female—Length 18 mm., of wing, 14 mm.

Frons and antennae as figured. Frons yellowish grey pollinose, callus dark brown, nearly black. Face and cheeks grey, beard sparse, white. Palpi yellowish, mostly black haired. Eyes bare, dark purplish with three narrow green bands, one below and two above the middle. Mesonotum chocolate brown, grey pollinose and with dark and light hairs forming indistinct stripes. Scutellum concolorous. Pleura grey pollinose and white haired. Legs reddish brown, the coxae and all posterior legs largely white haired, the fore femora, apical half of fore tibiae and all tarsi blackish and black haired. Base of fore tibiae white and white haired. Wings hyaline, the veins all blackish, faintly brown margined. Fork of third vein with a short appendix. Abdomen chocolate brown, with a continuous white haired mid-dorsal stripe of medium width, (.75 mm.) on segments one to six. Dorso lateral stripes formed of a series of more or less oblong, unconnected white haired patches which are not oblique, and which extend from tergites two to five inclusive. The dorsum of the abdomen is otherwise black haired. Sternites and extreme sides of tergites pale chocolate, white pollinose and white haired.

Holotype ♀ Vera Cruz, São Paulo, Brasil (A. Ramalho coll.). To be deposited in the collection of the Instituto de Hygiene, São Paulo, Brasil.

This species is the largest *Neotabanus* known to me, with the possible exception of *T. attenuatus* Wlk., which is described as a yellowish species with a quite different eye pattern.

Tabanus (Neotabanus) amplifrons Kröber

(Pl. II, fig. 17)

1933, Rev. Ent., III, 3, p. 354 (♀; Venezuela); 1934, Op. cit., IV, 3, p. 292.
?*Tabanus truquii* Bellardi, 1859, Ditt. Mess. Pt. 1, pp. 64–65 (♂; Mexico).
Tabanus truquii Hine, 1906, Ohio Naturalist, VII, 2, pp. 22, 28 (♂, ♀; Guatamala).
Tabanus trilineatus Bequaert, 1940, Bull. Ent. Res., XXX, pt. 4, pp. 450, 452 (Trinidad). ? Not *T. trilineatus* Latreille, 1811.

The earliest name for this species seems quite impossible to determine at present, but a brief resumé of opinions will perhaps serve to explain the conclusions expressed in the present paper. Bellardi's description agrees very well, but it is impossible to tell from it whether the large eye facets were much or only slightly larger than the small facets, so that I prefer for the present, following the suggestions of Drs. C. B. Philip and Alan Stone, to leave the name in abeyance. Bequaert stated that Major E. E. Austen had identified the species as *trilineatus* Latr. Through the kindness of Dr. C. B. Philip, I have been provided with a copy of Latreille's (1811) description. As was to be expected, it might fit almost any trivittate species. The description of the head is, however, very peculiar. "Les yeux sont d'un brun noirâtre, et séparés dans toute leur longeur, ce qui me fait presumer que l'individu que je decris est une femelle; l'intervalle compris entre eux est uni, et offre en devant une petite éminence d'un brun luisant portant les yeux lisses." Wiedemann (Auss. Zweifl. Insekt., I, p. 169, 1828) also was unable to identify the species, and called attention to the peculiar description of the head. It is possible that *trilineatus* was one of the *callosus* group, but it would be difficult to tell which. Kröber places *trilineatus* Latr. as a synonym of *lineola* Fab., though, as will be shown later, his *lineola* is not the same as the *lineola* of North American authors. In 1929 (Ann. Nat. Mus. Wien, XLIII, p. 248) Kröber describes under *truquii* Bell. a dark, greyish white striped form from the Amazon, which is not the same as his later *amplifrons*, but appears to be a greyish form of *carneus* close to what Hine called *appendiculatus*, at least in part. Later (1933, 1934) he placed Bellardi's name as a probable synonym of *occidentalis* Linn. In the Hine collection, specimens of the present species are labelled *dorsiger* Wied., while specimens labelled *trilineatus* "comp. with type" are what I here call *carneus*.

The species seems to be relatively uniform throughout its range. The frons is relatively wide, and parallel sided. The callus nearly square, yellow to brown, and the whole insect of a definitely grey tone, greyer than any of the other species familiar to me. The abdominal stripes are for the most part chalky white, but when underlain by a more than usually reddish ground, assume a pinkish tone. The wings are always completely hyaline, the stigma pale yellow and very slender. The hind femora of all females I have seen are entirely pale, those of the male always extensively blackish at base. The female venter always bears a large median dark patch on the first and second sternites, and often a complete broad black mid-ventral stripe or band. The eyes of the male have the facets very little differentiated, the larger merging imperceptibly into the smaller. The eyes are also densely pubescent, the pubescence thickest and longest on the larger facets, becoming sparse, short and barely visible on the smaller facets.

The species may be distinguished from the forms of *vittiger* by its greyer color, narrower frons, black scutellum and pure white stripes, as well as the male eye characters. From *lineola* and its forms the yellow callus, pale femora, grey color, black ventral patch, and glass clear wings should serve to separate it, as none of those forms has all these characters.

Distribution: I have seen material from Trinidad, Venezuela, Amazonas, Colombia, Panama, Guatemala and Texas.

Panama records: Ancon, C. Z. (Dunn); Miraflores, C. Z., Jan. 10, 1930 (Dunn); Panama City, May 16, 1930 (Dunn); Moja Pollo, Chagres River region, Feb., April, May, June, July and September, 1940.

Tabanus (Neotabanus) vittiger Thomson

(Pl. I, figs. 15, 16)

Tabanus vittiger Thomson, 1868, Svensk Freg. Eugenies Resa, Vet. Iakttag., 2, Zool., Pt. 1, Insekter, Heft 12, p. 451. Coquillett, 1901, Proc. Wash. Acad. Sci., III, p. 373. Johnson, 1924, Zoologica, V, p. 87. Curran, 1932, Norwegian Zool. Exped. Galapagos, Medd. Zoologiske Mus., Oslo, No. 30, p. 349; 1934, Proc. Cal Acad. Sci., Ser. 4, XXI, 13, pp. 150–151. Bequaert, 1933, Proc. California Acad. Sci., (4) 21, p. 136. (Galapagos Is.)

Tabanus guatemalanus Hine, 1906, Ohio Naturalist, VII, 2, p. 24. Kröber, 1933, Rev. Ent., III, 3, p. 358; 1934, Op. cit., IV, 3, p. 293.

Tabanus truquii Bequaert (nec. Bell.), 1940, Rev. Ent., XI, 1–2, pp. 352–357, fig. 30. Stone, 1938, U. S. Dept. Agric. Misc. Publ. No. 305, p. 123.

Tabanus appendiculatus Bequaert, 1940, Bull. Ent. Res., XXX, Pt. 4, pp. 451, 453 (♂ only, the ♀ is either *carneus* or *ochrophilus*).

I have seen Hine's types in Columbus, Ohio. They consist of 3 ♂ and 3 ♀ from San José, Guatemala, Feb. 5, 1905, and an additional female, not labelled as type, but with the same data. There is also a male from Mazatlan, Mexico. In addition to these, I have material from Panama and Trinidad which I have compared with the types. I believe also that *truquii* Stone, 1938, and *truquii* Bequaert, 1940, as well as *vittiger* Thomson, 1868, and an unnamed variety recently sent to me by Dr. Philip from the Southwestern United States are but varieties, subspecies or local races of the same thing. All, with the exception of *vittiger*, whose male is apparently unknown, have the male eye differentiated into large and small facets, the large facets very much larger than the small, and bearing rather dense and long pubescence. The females vary much in color, but seem always to have a relatively broad frons. While it may seem unwise to base the differentiation of this group almost wholly on the structure of the male eye, I have been unable to find any other character which seems to be anything like as consistent. The determination of female specimens is very much like trying to name the species of *Culex* from females alone, but the following key may be of some assistance in separating the various forms. These forms, incidentally, are probably what I consider true subspecies, i. e., geographical races, as from the limited material at hand, no two of them appear to occur in the same area.

KEY TO FORMS OF VITTIGER

1. Mid and hind femora dark or dusky at base. Coloration essentially black and white, with little brown or yellow. 2

Mid and hind femora wholly pale. Coloration often yellowish or brownish. . . 3

2. Mid abdominal stripe rather broad and white. Frontal callus brown, (Galapagos) **vittiger**

Mid abdominal stripe rather narrow. Frontal callus black, (**truquii** Stone, 1938) (Southeastern U. S.) **subsp. A**[3]

3. Coloration essentially black and white, the thorax grey, the abdominal stripes white or pale grey, (**truquii** Bequaert, 1940) (Puerto Rico and Cayman Is.) **subsp. caymanicus**

Coloration essentially yellowish and brown. Thorax yellowish grey, abdominal stripes yellow. 4

4. Coloration pale, washed out, vestiture mostly whitish, (Southwestern U. S.) **subsp. B**[3]

Coloration yellowish brown, darker, vestiture yellowish to brown, (Trinidad to Mexico) **subsp. guatemalanus**

The different forms, except *vittiger*, fly in company with various forms of *lineola*, and must be distinguished from them.

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[3] Subspecies A will appear in the 1942 Psyche, described by Philip as *schwardti*. Subspecies B will appear in the same article by Philip as ***nippontucki***. The above elements of the key which concern these forms and any descriptive item in the above text are by C. B. Philip. The two subspecies are thus described by Philip whether they appear first in Psyche, 1942, or whether the above descriptive references appear first in these Annals.—G. B. F.

Thus "*truquii*" Stone may be distinguished from *lineola* by the reddish scutellum and from *scutellaris* by the basal infuscation of the hind femora. Var. B., which I know only in the male, must be extremely difficult to separate in the female from pallid forms of *scutellaris*, since the femora are said to be pale. "*Truquii*" Bequaert and *guatemalanus* are separable from the *lineola* forms found with them by the much wider frons. *Vittiger* is apparently the only Tabanid found in the Galapagos.

Some explanation is perhaps necessary for the use of the name *vittiger*, since it is not known in the male; and the species as a whole is distinguished mainly on the condition of the male eye. Females of *vittiger* are, however, so like *guatemalanus* and *caymanicus* in structure, and are not closely approached by any other neotropical forms, that it seems highly probable that they belong here.

The West Indian form treated by Dr. Bequaert (1940) as *T.* (*Neotabanus*) *truquii*, is, I believe, a distinct race, for which the subspecific name, *caymanicus*, is here proposed. I have seen the following material in his collection. 1 ♂, 4 ♀, Cayman Is., April 17–August 26, 1938 (C. B. Lewis and G. H. Thompson). 1 ♀, Sta. Tomas, P. de Zapata, Cuba, May 5–9, 1927 (Bruner and Acuña). Since Bequaert has fully described and figured the form (l. c.), it is only necessary to point out a few characters in which it differs from other forms. The whole insect is rather dull and greyish, the mid abdominal stripe rather irregular, in some cases formed of truncate triangles. Lateral stripes quite irregular, almost step-like. Both stripes are greyish and not very well defined. The frons and callus are just like *guatemalanus*, but the callus brown rather than yellow. The male and a female from the Cayman Island lot are selected as Allotype and Holotype.

The two[4] North American varieties will be treated by Dr. C. B. Philip in a forthcoming paper, and I am much indebted to him for allowing me to examine his material.

In Panama, only *guatemalanus* occurs, where it seems to be confined to the drier areas along the Pacific coast, and appears to be rather uncommon.

Panama records: Miraflores, C. Z., Jan. 10, 1930 (Dunn); Balboa, C. Z., Dec. 7, 1929 (Dunn); Chepo, Jan., 1930 (Dunn); Old Panama (Dunn); El Real, Darien Prov., July 15, 1930

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[4] See footnote No. 3, p. 180, this article.

(Dunn); West side Ferry landing, opposite Balboa, C. Z., May 7, 1940.

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and **Neiva, Arthur.** 1914a. As "Tabanidae" do Estado do Rio de Janeiro. Mem. Inst. Oswaldo Cruz, VI, fasc. 2, pp. 69–80.

1914b. Notas Dipterolojicas. Contribuição para o conhecimento dos primeiros estadios de tabanideos brasileiros. Mem. Inst. Oswaldo Cruz, VI, fasc. 1, pp. 43–49.

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NOTES ON TABANIDAE (DIPT.) FROM PANAMA

VIII. THE GENERA PITYOCERA, SCIONE AND ESENBECKIA

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Genus **Pityocera** Giglio-Tos

1896, Bol. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 224, p. 3, (Monotypic for *P. festae* Gigl.-Tos.). Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 339; 1925, Op. cit., XI, 2, p. 298. Kröber, 1930, Zool. Anz., LXXXVIII, 11–12, p. 310.

The genus remains monotypic for a peculiar species known so far only from Panama, where it is quite abundant locally. The genus is placed in the tribe *Pityocerini* with *Elaphella* Bezzi and *Pseudelaphella* Kröber by Enderlein and Kröber. These two genera certainly seem its closest relatives, and form transitions between it and *Fidena*. The long-stalked first posterior cell seems characteristic of the group.

Pityocera festae Giglio-Tos

(Figs. 7, a, b)

1896, Bol. Mus. Zool. Anat. Comp. Univ. Torino, XI, No. 224, p. 4, fig. (♀; forest of Lake Pita and of the Rio Lara, Darien); 1897, Op. cit., XII, No. 276, p. 1 (♀). Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 135. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 99. Aldrich, 1905, Cat. North Amer. Dipt., p. 200. Kertesz, 1908, Cat. Dipt., III, p. 147. Surcouf and Gonzalez-Rincones, 1912, Dipt. Vulner. Venezuela, II, p. 86 (♀). Surcouf, 1921, Gen. Insect., Taban., p. 101, Pl. III, figs. 11a, 11b. Kröber, 1930, Zool. Anz., LXXXVIII, p. 311, fig. 5; 1934, Rev. Ent., IV, 2, p. 235.

This insect is immediately recognizable by the remarkable pectinate antennae. In general appearance it is a brown *Fidena*-like fly with smoky wings and dark concolorous brown thorax and abdomen, with small silvery hair tufts on the sides of the last few segments. The legs are pale yellowish, the face snout-like, largely shiny, and the proboscis nearly as long or longer than the whole insect.

The species is not at all uncommon in certain localities in Panama, but the season of flight is very short, my material showing dates from July 29 to Sept. 1. While collecting on the Pequeni river at the head of Madden Lake, C. Z., in August, 1940, I found the species very abundant. It was definitely crepuscular, not appearing much before 6 P. M., and continuing to fly long after it was too dark to see; only the loud and rather characteristic buzzing of the hovering flies told of their presence. The flies would alight readily on one's person, seeming to prefer the body below the waist, and while they would attempt to bite, they seemed to be dissatisfied with some factor, and seldom remained long enough to draw blood. Visits to the same locality at several other times of year have always failed to reveal their presence.

Distribution: So far known only from Panama.

Panama records: 1 ♀, Gatun, C. Z., July, 1919 (D. E. Harrower). 1 ♀, Quipo, July, 1922 (J. P. Chapin). 10 ♀, Sta. Rosa, Chagres River region, Aug., 1936 (L. E. Rozeboom). 5 ♀, Moja Pollo, Chagres River region, Aug. 18, 21, Sept. 1, 1940. Rio Pequeni, Aug. 18, 1940 (20 ♀), July 29, 1941 (1 ♀).

Genus **Scione** Walker

1850, Insect. Saund., Dipt., I, p. 10 (with *incompleta* as sole species). Coquillett, 1910, Proc. U. S. Nat. Mus., XXXVII, p. 604. Ferguson, 1924, Bull. Ent. Res., XIV, 3, p. 253. Surcouf, 1921, Gen. Insect. fasc. 175, Dipt. Taban., p. 113. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 299. Kröber, 1930, Stett. Ento. Zeit., XCI, p. 141. Borgmeier, 1933, Rev. Ent., III, 3, p. 301. Kröber, 1934, Rev. Ent., IV, 2, p. 232.

Diclisa Schiner, 1867, Verh. k.-k. zool.-bot. Gesell., Wien, XVII, p. 311; 1868, Reise Novara, Zool., II, Abt. 1, B, Diptera, p. 101 (Type *Pangonia incompleta* Macq.).

Rhinotriclista Enderlein, 1922, Mitt. Mus. Berlin, X, p. 338; 1925, Op. cit., XI, 2, p. 302 (Type, *Diclisa maculipennis* Schin.). Kröber, 1930, Stett. Ent. Zeit., XCI, p. 141. Bequaert, 1931, Journ. New York Ent. Soc., XXXIX, p. 538.

This genus includes a fairly well defined group of Neotropical *Pangoniinae*, whose center of distribution is apparently the Andean region from Peru to Colombia. Several species range into Venezuela and into Central America as far as Southern Mexico, but they seem for the most part to be confined to higher altitudes.

The genus may be recognized by the following combination of characters: Hind tibiae spurred. Ocelli present. Eyes with dense and long pubescence. Face moderately to considerably produced. Palpi parallel to proboscis, rather short, generally less than one-fourth length of proboscis, flattened, appressed, and either broad or slender. Proboscis long, as long as head and thorax, the labium annulate, the labella short and sclerotized. Body rather short and stout, legs slender, neither swollen nor especially hairy. Wings with subepaulet bare, both the first and fourth posterior cells closed and generally petiolate. Wings generally smoky or mottled, occasionally hyaline.

The species are rather similar in appearance, and good specific characters seem to be few, most of the earlier descriptions being nearly worthless. The group is in great need of revision, as Kröber's (1930) paper, the only attempt so far, does not seem to have been entirely successful. Five species have been recorded in the literature as occurring in Central America, but it is doubtful in some cases if the names used were correctly applied. I have before me specimens of four distinct species, three from Panama, and one from localities both north and south of Panama, and it is very likely that other species will be found when the mountains on the Colombian border become better known.

KEY TO FEMALES

1. Wings immaculate, either hyaline or fumose............................2
Wings with more or less distinct dusky clouds at base, apices of basal cells, fork of third vein and apex; remainder of wing faintly yellowish. Thorax brown, with well marked stripes. Abdomen with a row of small white haired middorsal triangles...............................**maculipennis**

2. Large blackish species, the wings brown fumose, the abdomen clothed with bright golden hairs. The thorax dark brownish black, nearly immaculate. Legs nearly black.......................................**aureopygia**
Smaller brown or yellowish species. The thorax and abdomen with tufts of contrasting hairs, or the whole insect pale yellowish.....................3

3. Thorax prominently whitish striped. Abdomen with white middorsal triangles..**claripennis**
Thorax unicolorous, dirty yellowish brown.......................**aurulans**

Scione aurulans (Wiedemann)

Pangonia aurulans Wiedemann, 1830, Auss. Zwiefl. Insekt., II, p. 620 (♀; Mexico). Walker, 1854, List. Dipt. Brit. Mus., V, Suppl. 1, p. 120. Osten Sacken, 1878, Cat. Dipt. N. Amer., p. 52. Kertesz, 1900, Cat. Taban., p. 16; 1908, Cat. Dipt., p. 152. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 170. Aldrich, 1905, Cat. N. Amer. Dipt., p. 193. Surcouf, 1921, Gen. Insect., p. 127. (*Pangonius*).

Scione aurulans, Hine, 1920, Ohio Journ. Sci., XX, 8, p. 314 (with *P. rostrifera* Bell. and *D. misera* O. S. as syns.); 1925, Occ. Papers Mus. Zool. Univ. Michigan, No. 162, p. 9. Bequaert, 1931, Journ. New York Ent. Soc., XXXIX, pp. 537–538.

Rhinotriclista aurulans, Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 302. Kröber, 1930, Stett. Ent. Zeit., XCI, 2, p. 147.

Pangonia rostrifera Bellardi, 1859, Sagg. Ditt. Messicana, I, p. 47 (♀, ♂; Mexico). Osten Sacken, 1878, Cat. N. Amer. Dipt., Smithson. Misc. Coll., No. 270, p. 52. Williston, 1901, Biol. Centr.-Amer., Dipt., I, Suppl., pp. 252, 253. Aldrich, 1905, Cat. N. Amer. Dipt., p. 193. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 169 (*Erephrosis*). Kertesz, 1908, Cat. Dipt., III, p. 166 (*Erephopsis*).

Erephopsis rostrifera, Surcouf, 1921, Gen. Insect. Taban., p. 120.

Scione lurida End., 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 301 (♀; Colombia; Brit. Honduras). Szilady, 1926, Biol. Hung., I, 7, p. 28.

Fidena rostrifera Kröber, 1933, Arch Naturg. (N. F.) II, p. 284.

?*Diclisa misera* Osten Sacken, 1886, Biol. Centr.-Amer., Dipt., I, pp. 47–48. (♀; Guatemala).

Hine (1920) synonymized *misera* with *aurulans* but Enderlein (1925) and Kröber (1930) claim that *aurulans* has the abdomen wholly light haired, *misera* with considerable black hair. Kröber records specimens from Orizaba, Mexico, and Laristal, Peru, a peculiar distribution, and says that the black hairs are apparently easily lost, and often are entirely lacking, while the yellow hairs are always present. It would seem rather difficult to separate the species, at least on this character. The species has been recorded from Mexico to Peru, and should occur in Panama, if all these records apply to the same species, but I have seen no Panama records and have not taken the species myself.

Scione aureopygia n. sp.

(Figs. 4, a)

Female—Length 17–18 mm., of wing 15–16 mm.

Frons about two and one-half times as high as wide, narrowest at the level of the median ocellus, dark brown pollinose, and with rather sparse short black hairs. The basal suture dividing the frons from the antennal eminence is quite faint. Eyes with unusually short pilosity. Face protuberant, snout-like, dark brown pollinose. Antennae dark brown, the first two segments reddish, the third, of eight annuli, nearly black. The first annulus is much the widest and longest, the segment tapering to the fourth annulus. Terminal palpal segment long, as long as third antennal segment, leaf-like, the margins thickened, and tapering to a sharp point. Proboscis longer than head and thorax, orange brown, the labium not annulate, the labella very small, black and shiny. Beard sparse, blackish.

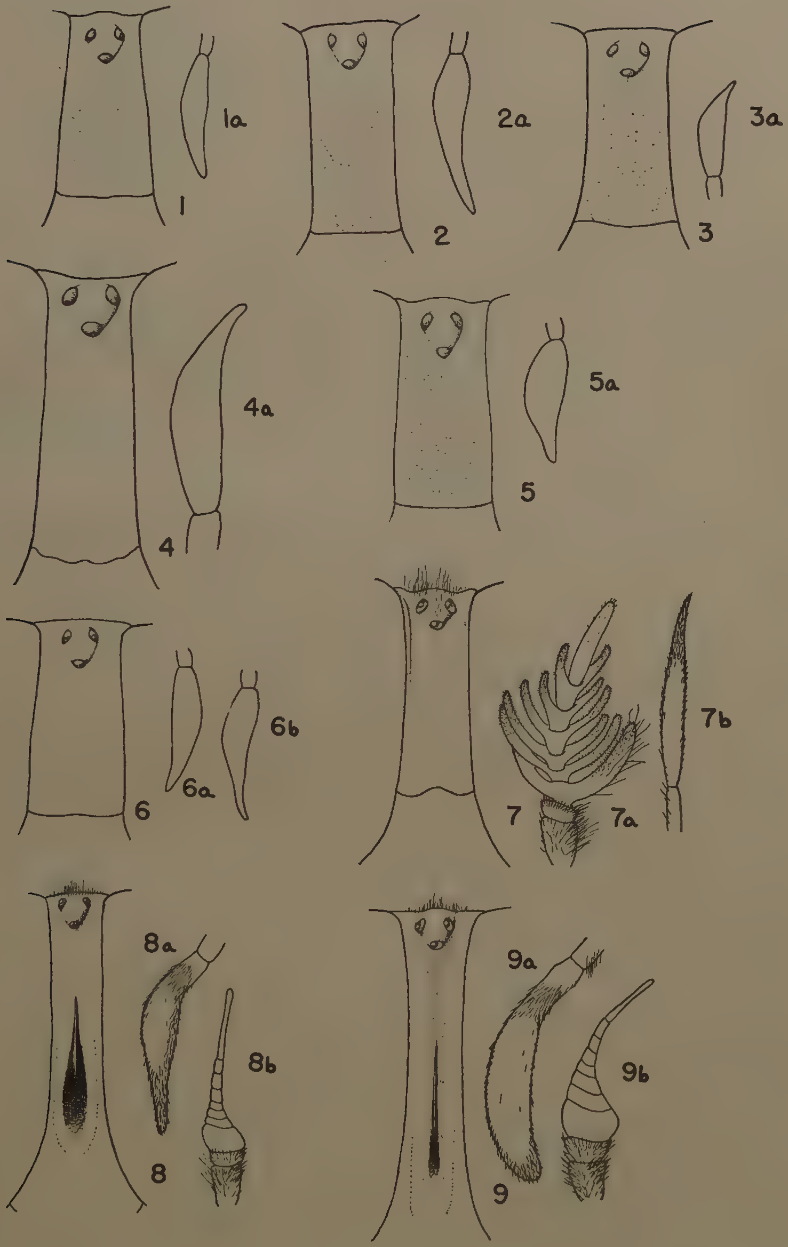
Mesonotum and scutellum chocolate brown, clothed with sparse blackish hairs, the former with three faint dark stripes. Pleura and coxae dark, black haired, the hairs on the antealar callus reddish brown. Femora black, or nearly so, black haired, fore and mid tibiae and tarsi orange brown, with orange and black hairs; hind tibia and tarsi darker. Wings brownish hyaline, first and fourth posterior cells closed and petiolate; a short appendix on the upper branch of the third vein in one specimen, none in the other. Abdomen above dark mahogany brown, entirely clothed with appressed golden rufous hairs, beneath blackish, the golden hairs sparser.

Holotype ♀ and 1 ♀ Paratype from Police Station, upper Pequeni river, Madden Lake, C. Z. Holotype to be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass. There are also 2 ♀, Porto Bello, April 22, 1912 (Busck coll.) in the U. S. Nat. Mus., determined as *Sc. rufescens* Ric. by me in 1938, which are almost certainly the present species.

EXPLANATION OF PLATE I

Fig. 1, a. *Scione albfiasciata* Macq. Sta. Marta, Colombia. 2, a. *Scione maculipennis* Schin. Restrepo, Colombia. 3, a. *Scione claripennis* Ric. El Valle, Panama. 4 a. *Scione aureopygia* sp. nov. Paratype. 5, a. *Scione maculipennis* Schin. Chiriqui, Panama. 6, a. *Scione distincta* Schin. Venezuela. 6 b. *Scione maculipennis* Schin. El Valle, Panama. 7, a, b. *Pityocera festae* Gig.-Tos. Panama. 8, a, b. *Esenbeckia mejiai* sp. nov. Holotype. 9, a, b. *Esenbeckia chagresensis* sp. nov. Paratype.

PLATE I


1
1a
2
2a
3
3a
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4a
5
5a
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6a
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7
7a
7b
8
8a
8b
9
9a
9b

This species is exceedingly close to *S. rufescens* Ric., from which it may be distinguished by its smaller size and darker coloring. It shows in the structure of the palpi and antennae a condition approaching the species of the genus *Fidena*, for one of which it might well be taken, except for the closed fourth posterior cell.

Scione claripennis Ricardo

(Figs. 3, a)

1900, Ann. Mag. Nat. Hist., (7) VI, p. 292 (♀; Peru); 1902, Op. cit., IX, p. 435. Surcouf, 1921, Gen. Insect., p. 114. Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 300. Szilady, 1926, Biol. Hung., I, (7), p. 28. Kröber, 1934, Rev. Ent., IV, 2, p. 233 (Peru, Bolivia, Ecuador, Panama).

Rhinotriclista claripennis Kröber, 1930, Stett, Ent. Zeit., XCI, 2, p. 154, fig. 5.

Rhinotriclista brevipalpis Enderlein, Mitt. Zool. Mus. Berlin, XI, 2, pp. 303–304 (♀; Bolivia). Kröber, 1930, Stett, Ent. Zeit., XCI, 2, p. 155. (=*claripennis* Ric.).

Rhinotriclista strigata Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 303 (♀; Sta. Inez, Ecuador). Kröber, 1930, Stett, Ent. Zeit., XCI, 2, pp. 152–153, fig. 4.

Scione strigata Kröber, 1934, Rev. Ent., IV, 2, p. 235.

Scione costaricana Szilady, 1926, Biol. Hung., I (7), p. 29, (♀; Turrialba, Costa Rica). Kröber, 1934, Rev. Ent., IV, 2, p. 233.

Rhinotriclista costaricana Kröber, 1930, Stett, Ent. Zeit., XCI, 2, p. 156 (Yungas de Coroico, Bolivia; Sta. Inez, Ecuador).

From the descriptions, it seems impossible to separate the above species, and as I lack any South American material, it is better for the present to use the oldest name. Szilady's description of *costaricana* is somewhat ambiguous, as his key gives the wings unspotted, but his description states that they have brown spots around the cross-veins. Kröber determined specimens as *costaricana*, *claripennis* and *brevipalpis* from Yungas de Coroico, Bolivia. All the species except *costaricana* were described from Bolivia, Peru or Ecuador, and neither Kröber nor Enderlein apparently saw Central American material.

A very well preserved specimen from El Valle, Panama, has the following characters: Length, 11.5 mm. Frons about two times as high as wide, very slightly narrowed at vertex, brown in the middle, whitish at sides. Palpi as figured. Beard yellow. Thorax dark brown, the usual *Scione* stripes distinct, whitish. Pleura mostly dark haired, pre-alar tuft dark, post-alar tuft yellow. Hairs on sides of notum yellowish brown, becoming long, silky and golden on each side of scutellum. Scutellum brown with long erect pale golden hairs. Wings nearly hyaline, the costal and first basal cells yellowish. Legs dark brown, densely black haired, the hind tibiae practically black. Abdomen brown on first two tergites, the remainder nearly black. Sides of first tergite behind with white hairs, a fairly broad white haired hind marginal band on second tergite, and tergites one to five with prominent silvery white median triangles. Tergites 3 to 5 all have small silvery white tufts at the sides. Beneath the sternites are dark brown, with sparse white hairs at the sides. The second and fifth sternites appear to have entire white haired hind margins. Specimens from Chiriqui, though not well preserved, seem to have more white on the abdomen, in one case complete white bands on tergites 3–6. The palpi are also somewhat broader and blunter.

Panama records: Panama (Kröber). Buena Vista, Chiriqui Mt., 1000 ft. March, 1926, (J. D. Smith). El Valle, Coclé Prov., 2500 ft., Jan. 24, 1941 (G. B. Fairchild).

Scione maculipennis (Schiner)

(Figs. 1, 2, 5 and 6)

Diclisa maculipennis Schiner, 1868, Reise Novara, Zool., II, Abt. 1, Vol. B, Dipt., p. 102, Pl. II, figs. 7, 7a (♀; South America, Venezuela). Osten Sacken, 1886, Biol. Centr.-Amer., Dipt., I, p. 47 (♀; Chiriqui Volcano, 3000-4000 ft., Panama). v. Roder, 1886, Stett, Ent. Zeit., XLVII, p. 262 (Colombia); 1892, Dipt. Gesamm. Sud-Amerika von A. Stubel, p. 8. Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 135. Kertesz, 1900, Cat. Taban., p. 14. Surcouf, 1921, Gen. Insect. Taban., p. 113.

Scione maculipennis Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 14; 1902, Op. cit., (7) IX, p. 435 (♀; Bogota). Hine, 1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 9 (Boquete, Chiriqui, Panama). Szilady, 1926, Biol. Hung., I, 7, p. 28. Kröber, 1930, Stett. Ent. Zeit., XCI, pt. 2, pp. 144, 165, fig. 10 (♀; Ecuador, Peru, Venezuela, Mexico); 1934, Rev. Ent., IV, 2, p. 234.

Rhinotriclista maculipennis Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, 2, p. 302.

The identification of Panama material is tentative, as I lack the long series of specimens from neighboring territory necessary for elucidation of the limits of variation of the several forms which have been described. Specimens determined by Dr. Bequaert as *maculipennis* Schin., *albifasciata* Macq., and *distincta* Schin., are before me, and are figured here for comparison. Specimens from Chiriqui province are intermediate between *maculipennis* and *albifasciata* in many respects, while the specimens from El Valle, Coclé province, is the same as *distincta* in the proportions of the frons, though the palpi are rather different. The general color of the Panama material is rather brown, the beard yellowish and the legs dark brown, thus more like *maculipennis*, but more yellowish than *albifasciata*. The balance of the evidence seems to place the material nearest to *maculipennis*.

Specimens examined: 1 ♀, Restrepo, Dept. Meta, Colombia, 1936, (J. Bequaert coll.), (*maculipennis*) (Figs. 2, a). 1 ♀, N. W. Sierra N. de Sta. Marta, Colombia, 7000–8000 ft., July 21, 1928. (P. J. Darlington coll.), (*albifasciata*) (Figs. 1, a). 1 ♀, Aragua, Venezuela, Sept. 8, 1936 (*distincta*) (Figs. 6, a).

Panama records: Volcan de Chiriqui, (Osten Sacken). Boquete, Chiriqui, March, 1923 (Hine). 1 ♀, El Valle, Coclé prov., Jan. 24, 1941. 2 ♀ Rio Chiriqui Viejo, Llanos de Volcan, Chiriqui Prov., 7–7500 ft., Jan., 1939, (P. Allen coll.). 1 ♀, Boquete, Chiriqui, Jan., 1941. 5 ♀, Cerro Punta, Chiriqui, 6–7000 ft., Feb.-March, 1940.

Genus **Esenbeckia** Rondani

1863, Arch per la Zool., Modena, III, p. 83 (type by original designation: *Silvius vulpes* Wiedemann, 1828). Lutz, 1909, Zool. Jahrb., Suppl. X, pp. 625, 627, 661. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 287. Kröber, 1931, Zool. Anz., XCIV, p. 245; 1932, Rev. Ent., II, 1, p. 82. Borgmeier, 1933, Rev. Ent., III, 3,p. 292. Kröber, 1934, Rev. Ent., IV, 2, p. 240.

Dyspangonia Lutz, 1905, Rev. Soc. Sci. Sao Paulo, I, 1, pp. 22, 27; 1906, Soc. Sci. Sao Paulo (separate publication), p. 3. Bequaert, 1924, Psyche, XXXI, 1, p. 28. (Type *Pangonia fuscipennis* Wied., 1828). Borgmeier, 1933, Rev. Ent., III, 3, p. 291.

Esenbackia Surcouf, 1909, Bull. Mus. Hist. Nat. Paris, XV, p. 257. (lapsus).

Kröber (1934) lists 30 species and 6 varieties as belonging to the genus, of which but 5 are said to occur in Central America. Of these I recognize 3 in the material before me, *prasiniventris* Macq., *translucens* Mac. and *illota* Will., the first two from Panama. Kröber's record of *filipalpus* Will. from Costa Rica needs confirmation, as the species was described from Paraguay. *E. fuscipennis* var. *minor* Kröber from Costa Rica I have not seen.

The four species I have taken in Panama are none of them rare, but all seem to have quite short seasons of flight. *Prasiniventris* is the most abundant and widespread, and flies throughout the day. *Translucens* and *chagresensis* are more or less crepuscular, while *illota osornoi* is strictly crepuscular and nocturnal. In addition, I have added the description of an apparently new species from Honduras.

The genus as found in Panama may be characterized as follows: Eyes bare. Ocelli present. Frons with or without a bare frontal callus, often secondarily denuded. Face pollinose, rarely shining, flat or somewhat inflated, not snout-like. Antennae with first two segments short, the first at least twice as long as the second. Third segment of eight annuli, the first four tending to become fused, the last slender and spike like. Palpi about half length of proboscis, slender, curved, and flattened. Proboscis equalling or somewhat exceeding head height, the theca of the labium and the labella with shiny sclerotized plates, the latter one-third to one-fifth the length of the proboscis. Wings with subepaulet without macrotrichia, the costa and first longitudinal vein above and the costa beneath with macrotrichia, other veins all bare.

First posterior cell closed and usually petiolate. Upper branch of third vein with a moderate to long appendix. Legs slender, short haired, the mid and hind tibiae with a pair of well marked apical spurs. Abdomen moderately slender to rather broad.

KEY TO FEMALES

1. Wings heavily fumose. Body and legs largely black........................2
   Wings hyaline or greyish. Body and legs not black........................3
2. Mesonotum and scutellum orange brown, with orange pubescence. .**translucens**
   Mesonotum and scutellum blackish, with black hairs and grey pubescence, **chagresensis**
3. Thorax and abdomen concolorous, pale yellowish brown. Palpi slender, sharp pointed. No tufts of white hair on sides of abdominal tergites 3 to 5, **illota osornoi**
   Thorax purplish brown, abdomen deep jade to light yellowish green in life, fading in long preserved specimens to yellowish. Palpi slender, blunt pointed. Fairly prominent tufts of white hairs on sides of tergites 3–5, **prasiniventris**

Esenbeckia translucens (Macquart)

(Figs. 15, a, b)

Pangonia translucens Macquart, 1845, Mem. Soc. Sci. Lille (1844), p. 154, Pl. III, fig. 5 (♀; Brasil); 1846, Dipt. Exot., Suppl. I, p. 26, Pl. III, fig. 5. Walker, 1854, List Dipt. Brit. Mus. V, Suppl. 1, p. 130. Rondani, 1863, Arch. per la Zool., Modena, III, 1, p. 85. Kertesz, 1900, Cat. Taban., p. 24. Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 134. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 171. Hine, 1920, Ohio Journ. Sci., XX, No. 8, p. 312 (♀; Ecuador, Panama, Guatemala); 1925, Occas. Pap. Mus. Zool. Univ. Michigan, No. 162, pp. 4, 7.

Esenbeckia translucens Lutz, 1909, Zool. Jahrb., Suppl. X, p. 670. Surcouf, 1921, Gen. Insect., Taban., p. 115. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 288. Kröber, 1931, Zool. Anz., XCIV, p. 249; 1932, Rev. Ent., II, 1, p. 71, fig. 19 (♂, ♀; Ecuador, Brasil, Peru); 1934, Rev. Ent., IV, 2, p. 243.

Pangonia fusiformis Walker, 1850. Insect. Saund., I, Dipt., p. 19 (♀; "North America" [Mexico according to Ricardo]); 1854, List Dipt. Brit. Mus., V, Suppl. 1, p. 95. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, pp. 169–170. Kertesz, Cat. Taban., p. 19. Surcouf, 1921, Gen. Insect., Taban., p. 128.

Phyrta fusciformis Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 394.

This species is probably not uncommon at suitable localities and at the right season, but I have happened to find the right combination only once, on Cerro Azul. It differs from its nearest congener, *E. diaphana* (Schiner) in having nearly wholly black legs. The rufus thorax will quickly distinguish it from *E. chagresensis*.

Distribution: Recorded in the literature from Mexico, Guatemala, Panama, Ecuador, Brasil and Peru. Dr. Bequaert has material from Colombia also. Specimens in the Hine coll. from Cabima, Panama and Cayuga, Guatemala are labelled *Buplex fusiformis* Wlk.

Panama records: 33 ♀ Canal Zone, Cabima, Boqueron River, and Alhajuela (A. Busck coll. in U. S. N. M.). 1 ♀ Summit, C. Z., June, 1930 (Dunn). 2 ♀; New San Juan, Chagres River region, June 26, 1939; 6 ♀, June 28, 1939. 1 ♀

El Valle, Coclé province, 2–2500 ft. July 9, 1939. 11 ♀ Cerro Azul, near Pacora, Panama province, 2000 ft., May 17, 1941. 2 ♀ Cano Saddle, Gatun, C. Z., June 13, 1923 (R. C. Shannon).

Esenbeckia chagresensis sp. nov.

(Figs. 9, a, b)

Female—Length 16–18 mm., of wing 16–18 mm. Eyes bare, dull greenish black in life.

Frons yellowish grey pollinose, about five times higher than wide, widened at base and vertex, the basal suture obsolete. The frontal callosity in well preserved examples is represented by a slightly raised stripe from base to vertex covered with darker and more yellowish pollinosity. This stripe is broader at base, where it flattens out and runs down over the subcallus to the base of the antennae, and in rubbed specimens the upper and middle portions may become denuded, showing a more or less uneven shiny strip. The ocelli are prominent and yellow. Antennae orange yellow. The first segment somewhat inflated, the second small and produced in a short blunt tooth dorsally, both with numerous black hairs, which form an even apical fringe on the second segment. Third segment of eight visible divisions, the first forming a broad basal piece with the following three, which are progressively smaller, while the last four form a sort of style. The fourth division is markedly the smallest, while the terminal piece is spike-like, as long or longer than the previous four divisions together. Clypeus and genae dark grey pollinose, with some dark hairs and light hairs forming tufts near the insertion of the palpi and along the genal margin of the eye. Genae with a deep groove running from the insertion of the palpi to a point even with the insertion of the antennae. Palpi black, curved, broad, blunt pointed, longer than antennae and clothed with black hairs on the inner surface, edges, and basal one-fifth of the outer surface. The inner surfaces of the palpi are round in cross section, the outer bare surfaces flat. Proboscis black, shiny, about equal to head height, the labella and theca of the labium both entirely sclerotized, the former a little less than one-half length of latter.

Mesonotum chocolate brown, covered with white pollen giving it a purplish cast, and with sparse black hairs. Pleura and sternum dark grey with white hairs. Scutellum concolorous with mesonotum. Prescutellar lobe prominent. Subepaulet subtriangular, thin, scale-like, without macrotrichia. Costa and first vein above and beyond arculus with macrotrichia, other veins bare. First posterior and anal cells closed and petiolate, a moderate appendix on the upper branch of the

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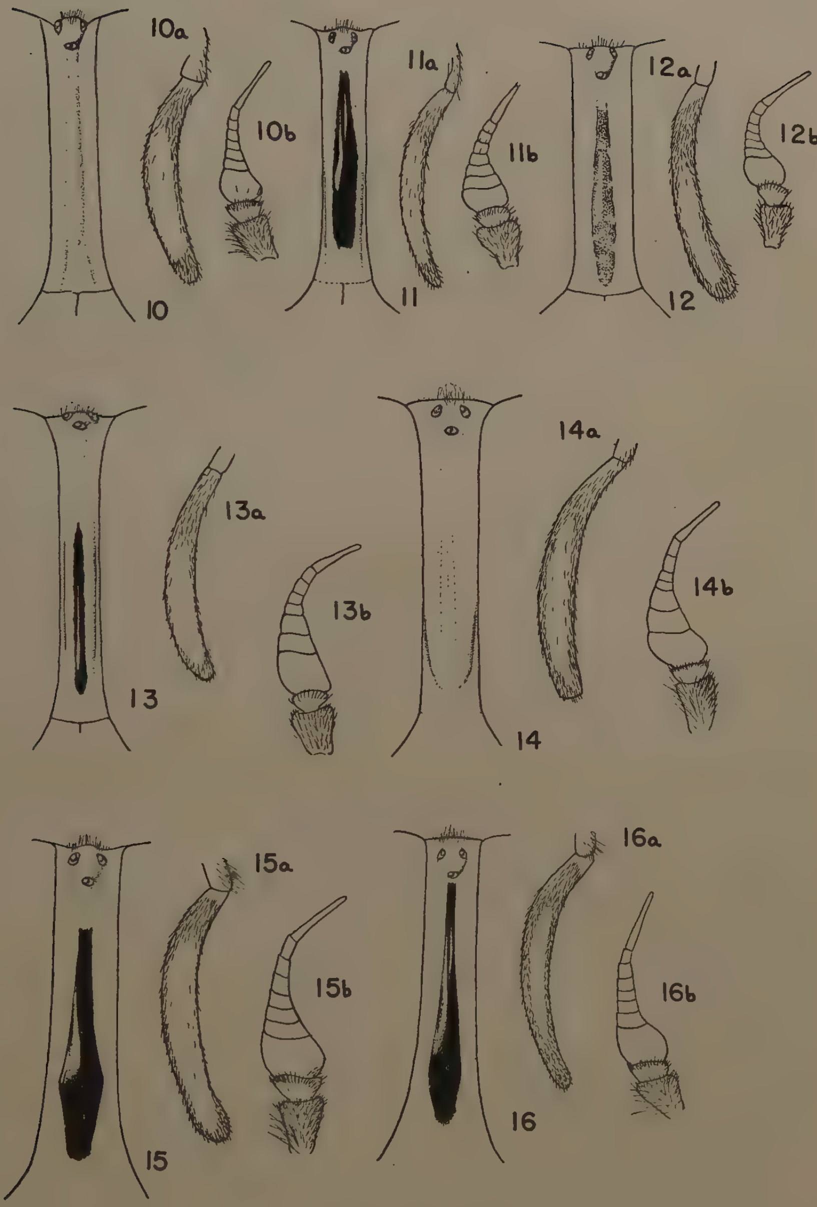
EXPLANATION OF PLATE II

10, a, b. *Esenbeckia illota* Will. Honduras. 11, a, b. *Esenbeckia illota osornoi* subsp. nov. Paratype, Panama. 12, a, b. *Esenbeckia illota enderleini* Kröb. Goyaz, Brasil. 13, a, b. *Esenbeckia illota guianense* subsp. nov. Holotype, Bartica, British Guiana. 14, a, b. *Esenbeckia illota meridionale* subsp. nov. Holotype, Ilheus, Bahia, Brasil. 15, a, b. *Esenbeckia translucens* Macq. Panama. 16, a, b. *Esenbeckia prasiniventris* Macq. Panama.

PLATE II



third vein. Whole wing deeply fumose. All legs entirely black with black hairs. Coxae white haired.

Abdomen: First tergite straw yellow, translucent, with white hairs on the lateral and posterior margins, black hairs in a small patch on each side of the scutellum. Second tergite varying from clear yellow with a small brown spot on each lateral margin to entirely black. Succeeding segments black. All tergites with narrow light hind margins which bear white hairs, while the yellow or black anterior four-fifths of the segments bear black hairs. Venter: First two or three sternites largely yellow with lateral black patches, or entirely black with light hind margins. Fourth to terminal sternites black with light hind margins.

Holotype ♀ and many ♀ paratypes from New San Juan, in the Chagres River valley between Gamboa and Madden Dam, C. Z., June 26, 1939, on horse. 1 ♀ paratype from Rio Frio, Magdalena, Colombia, October 15, 1927. (Geo. Salt. coll. in Dr. J. Bequaert's collection). 1 ♀ Paratype, Utevey, near Pacora, Aug. 6, 1941. 25 ♀ Paratypes, Moja Polla, Chagres river region, June 12, 24, July 8, 1940; June 15, 1941. Holotype and 5 Paratypes to be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass. Remaining Paratypes in the author's collection.

Esenbeckia illota (Williston)

(Figs. 10 to 14)

Pangonia illota Williston, 1901, Biol. Centr.-Amer., Dipt., I, p. 254 (♀; Ruatan Island, Rep. Honduras). Aldrich, 1905, Cat. North Amer. Diptera, p. 193. Kertesz, 1908, Cat. Dipt., III, p. 155.

Pangonius illota Surcouf, 1921, Gen. Insect., Taban., p. 128. Hine, 1925, Occas. Papers Mus. Zool. Univ. Michigan, No. 162, p. 5.

Esenbeckia illota J. Bequaert, 1932, Jl. New York Ent. Soc., XXXIX, (1931), p. 536 (♀); 1933, Publ. No. 431, Carnegie Inst. Washington, p. 560 (♀). Kröber, 1934, Rev. de Entomologia, IV, pt. 2, p. 242.

Pangonia ferruginea Macquart, 1839, (Not of Meigen, 1804. See below). Mem. Soc. Sci. Agric. Lille (1838), Pt. 3, p. 295, (♀; northern part of the Capitainerie of Sao Paulo, Brasil); 1838, Dipt. Exot., I, pt. 2, p. 179. Walker, 1854, List Dipt. Brit. Mus., V, Suppl. 1, p. 129. Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 171. Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 134. Kertesz, 1900, Cat. Taban., p. 18; 1908, Cat. Dipt., III, p. 154.

Dyspangonia ferruginea Lutz. 1905, Rev. Soc. Sci. Sao Paulo, No. 1, p. 28 (Goyaz, August).

Esenbeckia ferruginea Ad. Lutz, 1909, Zool. Jahrb., Suppl. X, pt. 4, p. 667, Pl. III, fig. 45 (♀; Amaro Leite and Rio dos bois, Est. Goyaz; also Est. Minas Geraes). Ad. Lutz and Neiva, 1909, Mem. Inst. Osw. Cruz, I, pt. 1, p. 32 (Bicudos, Est. Minas Geraes). Neiva and Penna, 1916, Mem. Inst. Osw. Cruz., VIII, pp. 93 and 97 (Formosa, Est. Bahia; Parnagua, Est. Piauhy). Surcouf, 1921, Gen. Insect., Tabanidae, p. 115 (Brasil). J. Bequaert, 1925, 13th Rept. United Fruit Co. Med. Dept. for 1924, p. 15. Kröber, 1934, Rev. de Entomologia, II, pt. 1, p. 65, fig. 11 (♀; Venezuela).

Esenbeckia enderleini Kröber, 1931, Zool. Anz., XCIV, p. 252, fig. 2 (♂; Tucuman, Argentina); 1932, Rev. Ent., II, 1, p. 64; 1934, Op. cit., IV, 2, p. 241 (♂, ♀; Argentina, Brasil).

NOT *Tanyglossa ferruginea* Meigen, 1804, Klass. Zweifl. Insekt., I, p. 175, Pl. 10, fig. 2 (Spain ?).

NOT *Pangonia ferruginea* Latreille, 1809, Gen. Crust. et Insect., IV, p. 282. Meigen, 1820, Syst. Beschreib. Europ. Zweifl. Insekt., II, p. 24. Walker, 1854, List. Dipt. Brit. Mus., V, p. 118. Loew, 1856, Neue Beitr., VI, p. 28. Schiner, 1868, Novara Reise, Zool., II, Abt. 1, Vol. B, Dipt., p. 99 (♂; Gibraltar). Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 181 (♂; France). Kertesz, 1900, Cat. Taban., p. 18. Villeneuve, 1905, Ann. Ent. Soc. France, LXXIV, p. 309. Arias, 1915, Dipt. Espana, No. 19, p. 60. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 286, 287.

The group to which this species belongs seems to be in a considerable nomenclatorial tangle, and the material available has not shed much light on the matter. *E. ferruginea* Macq., described from ''au Nord du capitainerie de St. Paul,'' is represented by a considerable series of specimens from Anapolis, Goyaz and 2 ♀ from Abuna, Matto Grosso, Brasil, which I consider to be true *ferruginea*. *E. illota* Will., described from Ruatan Is., Rep. Honduras, I have from Prieta, Rep. Honduras. These two forms are quite distinct, though obviously related. Specimens from localities between these northern and southern limits appear to differ in slight details of color and structure from both *illota* and *ferruginea*, and to differ among themselves sufficiently for three types to be distinguishable, which I consider to be races or subspecies which serve to connect the two end forms. The accompanying figures will serve to show the main structural differences between the various forms, while the slight color differences are described below. As shown above, *ferruginea* Macq., 1838 is apparently a homonym of *ferruginea* (Meig.), which leaves *illota* Will. as the earliest available name for the group, and the others are all considered to be subspecies of it.

Esenbeckia illota illota Will.

Frons, antenna and palpus as figured. Whole insect pale brown. Mesonotum clothed with yellowish brown hairs and greyish pubescence. Pleura paler, the hairs more yellowish. Beard sparse, creamy. A tuft of brown hairs on the genae at the lower corner of the eye, and a row of brown hairs along the anterior eye margin bordering the face. Antennae and palpi pale yellowish orange, the hairs on the palpi black those on the basal antennal segments dark brown. Legs yellow, orange haired. Abdomen yellowish brown, horn colored, the first tergite markedly lighter. Hairs on first tergite pale yellowish, those on remaining tergites reddish brown. Each tergite with a small tuft of pale hairs at the extreme latero-posterior angle. First sternite pale haired, the rest dark haired with narrow posterior fringes of pale hairs. Knob of haltere pale yellow.

Described and figured from a female from Prieta, Rep. Honduras, May 5, 1924 (J. Bequaert coll.). Recorded in the literature from Yucatan, Honduras and British Honduras.

Esenbeckia illota osornoi subsp. nov.

Frons, antenna and palpus as figured. Differs from the typical form in more orange antennae, sparser beard, thorax more yellowish, first tergite not paler than the others, all tergites orange haired, no pale lateral tufts, sternites all orange haired and knob of haltere orange brown. Specimens before me seem also to be smaller and more slender than the few *illota* I have seen.

Holotype ♀ and 45 ♀ Paratypes, Moja Pollo, Chagres River Valley, Jan., Feb., and March, 1940. 1 ♀ Paratype Canal Zone Forest Reserve, Feb. 22, 1942. Other Paratypes Boca de Cupa, Darien Province, Panama, March, 1939; Barro Colorado Is., C. Z., March, 1934; Puerto Armuelles, Chiriqui Province, January, 1940; Juan Mina Station, Chagres River valley, Feb. 17, 1939. 1 ♀, Restrepo, Colombia (P. C. A. Antunes coll.). There is also a considerable number of specimens from various localities in Colombia in Dr. Bequaert's collection, which are unfortunately not before me, although I have examined them.

There are also 2 ♀ in the Hine coll. from San Mateo, Costa Rica, and Crystalina, Colombia, labelled *Buplex tenuirostris* Walk., a name placed as a synonym of *Ricardoa flavohirta* (Bell.) by Kröber, but which appear to be the same as my Panama specimens.

Esenbeckia illota guianense subsp. nov.

Frons, antenna and palpus as figured. Coloration practically as in *osornoi*, but rather darker and more reddish throughout. Hairs on palpi and basal antennal segments definitely rufous. Proboscis apparently thicker and heavier than in *osornoi*.

Described and figured from the Holotype, a ♀ from Bartica, British Guiana, June 6, 1901. 1 ♀ Paratype, Caura Valley, Venezuela.

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(p.478)

Esenbeckia illota meridionale subsp. nov.

Frons, antenna and palpus as figured. Coloration much as in the preceding two forms, but differing as follows: Antennae pale yellow, hairs on basal segments and on palpi rufous. Beard rather heavy, creamy white. Tufts of paler hairs present on the latero-posterior margins of the tergites. Sternites with wholly pale straw colored hairs. Knobs of halteres dark brown, contrasting strongly with the pale pedicels.

Description and figures drawn from the Holotype, a female from Ilheus, Bahia, Brazil, August 30, 1934. I have seen other material from the same locality, but its distinctness was not then recognized.

Esenbeckia illota enderleini Kröb.

Frons, antenna and palpus as figured. Coloration in general rather paler than the preceding forms. Antennae ivory white, the hairs on the basal segments yellow. Hairs on palpi black. Beard sparse, nearly white. Hairs on thorax and abdomen, both above and below, pale straw colored, and rather denser and longer than on the other forms. In addition, many specimens bear faint median dark integumentary spots or streaks on the second to fifth tergites, and occasionally dorso-lateral spots of the same nature on the 3rd, 4th and 5th tergites can be made out.

Description drawn from a female from Pyrenopolis, Goyaz, Brazil, Aug. 10, 1936 (A. N. Allen coll.). I have seen material of this form from the States of Goyaz, Matto Grosso and Sao Paulo, Brasil. Kröber considered the form from Venezuela to be true *ferruginea*, while *enderleini*, described from the male from Tucuman, Argentina, he later records also from Brasil. The characters he uses to separate the two species (1932) are just those here used, while his figure of *ferruginea* agrees fairly well with my material from British Guiana and Venezuela. *Esenbeckia ferruginea* var. *nigrovillosa* Kröb., of which I have specimens from Goyaz, Brasil, determined by Dr. O. Castro, appears to be a distinct species, as the proboscis is quite different in structure, the theca of the labellum greatly inflated and heavily sclerotized, the labella large and also heavily sclerotized.

Esenbeckia prasiniventris (Macquart)

(Figs. 16, a, b)

Pangonia prasiniventris Macquart, 1845, Mem. Soc. Sci. Lille, (1884), p. 161, Pl. III, fig. 9; 1846, Dipt. Exot., Suppl. 1, p. 29, Pl. III, fig. 9 (♀; Colombia). Walker, 1854, List. Bipt. Drit. Mus., V, Suppl. 1, p. 130. Rondani, 1863, Arch. per la Zool., Modena III, 1, p. 85. Schiner, 1868, Novara Reise, Zool., II, Abt. 1, Vol. B, Dipt., p. 101 (♀, ♂). Osten Sacken, 1886, Biol. Centr.-Amer., Dipt., I, p. 45 (♂; Panama). Ricardo, 1900, Ann. Mag. Nat. Hist., (7) V, p. 173. Hine, 1917, Trans. Amer. Ent. Soc., XLIII, p. 291 (Guatemala, Costa Rica, Ecuador, British Guiana). Dunn, 1934, Psyche, XLI, p. 171 (Panama).

Pangonia prasiventris Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 134, (lapsus).

Pangonius prasiniventris Hine, 1925, Occ. Papers Mus. Zool. Univ. Michigan, No. 162, p. 5 (Honduras, Guatemala).

Esenbeckia prasiniventris Lutz, 1909, Zool. Jahrb., Suppl. X, 4, p. 670 (♂, ♀); 1911, Mem. Inst. Osw. Cruz., III, p. 84. Surcouf, 1921, Gen. Insect., Taban., p. 84. Kröber, 1931, Zool. Anz., XCIV, pp. 246–247; 1932, Rev. Ent., II, p. 55, figs. 3–4; 1934, Rev. Ent., IV, 2, p. 242. Bequaert, 1924, 13th Ann. Rep. Med. Dept. United Fruit Co., p. 205; 1940, Bull. Ent. Res., XXX, 4, p. 448. Lutz, 1928, Est. Zool. Parasit., Venezolanas, p. 56. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 288. Curran, 1934, N. Amer. Dipt., p. 152, fig. 25 (head), p. 153, fig. 29 (wing).

Esenbeckia semiviridis Kröber, 1931, Zool. Anz., XCIV, p. 247; 1932, Rev. Ent., II, 1, p. 57, figs. 5–6; 1934, Rev. Ent., IV, 2, p. 242 (Venezuela).

NOT *Pangonia semiviridis* Ricardo, 1900, Ann. Mag. Nat. Hist., (7) VIII, p. 181, Pl. I, fig. 7 (♂; Barengo, Old Castile [Spain]).

There is considerable variation in this species, the ground color of the abdomen ranging from deep jade green to light yellowish green, while the vestiture of the thorax may be largely grey or quite rufous. The males are generally yellower and paler than the females.

Prasiniventris is the most abundant species of the genus in Panama, but like the other species its season of flight is rather short, from about the middle of December to the middle of February. During this period, however, it assumes almost epidemic proportions, and is a severe pest to stock, even attacking man. The flight is swift and noisy, and the flies are not easily discouraged, returning again and again to the attack.

Distribution: Recorded in the literature from Guatemala, Honduras, Costa Rica, Panama, Colombia, Ecuador, Venezuela, British Guiana, Trinidad and Brasil (Minas Geraes). I also have specimens from Stann Creek, Brit. Honduras, Feb. 19, 1940 (Komp coll.).

Panama records: Camp La Vaca, Chiriqui, Feb., 1930 (Dunn). David (Osten Sacken). Buena Vista, Chiriqui, 1000 ft., March, 1926 (J. D. Smith). El Valle, Coclé Prov., Dec. 8, 1938; Dec. 10, 17, 1939; Jan. 24, 1941. Taboga Is., Dec. 18, 1938. Ft. Clayton, C. Z., Jan. 23, 1939. Chepo; June 19, 1930 (Dunn). Summit, C. Z., Dec. 21, 1929 (Dunn). Utevey, near Pacora, Aug. 6, 1941. Also a long series from Moja Pollo, on the Chagres River and the C. Z. Forest Reserve along Madden Road, at various dates in Dec., Jan., and Feb. Ancon, C. Z. (Dunn). Paraiso, C. Z., Jan. 16, 1911 (Busck).

Esenbeckia mejiai sp. nov.

(Figs. 8, a, b)

Female—Length 15 mm., of wing, 16 mm.

Frons about seven times as high as wide, yellowish grey pollinose, the callus brown. Ocellar tubercle and subcallus dusky pollinose. Fronto-clypeus rather strongly inflated, shiny yellow. Genae shiny yellow, yellow pollinose towards the eye margins. Beard sparse and short, dusky brown. Antennae orange, the basal segments black haired, the terminal annulus unusually long and slender. Palpi orange, black haired, the apex drawn out in a slender point. Proboscis longer than head height, the labella less than one-fifth its length, and apparently well sclerotized.

Mesonotum greyish brown, clothed with yellowish brown and dark grey hairs. Scutellum concolorous. Pleura more yellowish. Wings greyish fumose, the costal and basal cells yellowish. First posterior cell closed and short petiolate, third vein with a long appendix. Legs orange brown, coxae and at least bases of femora black haired.

Abdomen dirty yellowish, horn colored. First tergite yellowish haired, second and succeeding tergites black haired anteriorly, but with long, pale straw colored hairs on the hind margins. These pale hairs become more abundant laterally, where they cover practically the width of the segment, and on the terminal segments they practically replace the dark hairs. Venter wholly yellowish and pale haired.

Holotype ♀ Tegucigalpa, Rep. of Honduras, November, 1941. (Dr. I. Mejia coll.). To be deposited in the Museum of Comparative Zoology, Cambridge, Mass. This species much resembles *illota* and its allies in coloration, but the structure of face, antennae and palpi is entirely distinct. It is the only shiny faced species of the genus I have seen.

EXPERIMENTAL EMBRYOLOGY, (A MANUAL OF TECHNIQUES AND PROCEDURES), by ROBERTS RUGH. Pages i-vi and 1-302, 72 pages of figs. 1941. Mimeograph, spiral back, card cover, 8½ x 11 inches. Published by NEW YORK UNIVERSITY BOOKSTORE, 18 Washington Place, New York. Price, $3.00.

While this laboratory guide is almost wholly based on vertebrate material we call attention to it because it is the most complete guide on embryology that we have seen. It is a volume that would be of great use to students following the experimental procedures of such workers in the realm of vertebrate embryology as Spemann, Waddington and Paul Weis. We believe that it can be of much use in any laboratory where work on insect embryology, especially of an experimental nature, is carried on.

The table of contents is the only key to the volume as there is no index. Following a list of about forty "Reference Books for Experimental Embryology" the contents are divided as follows:

BASIC PROCEDURES (including) General operative procedure, Histological hints: EXPERIMENTS ON THE EGG (including) Artificial parthenogenesis, Androgenesis, the Amphibian germinal vesicle: FERTILIZATION (including) Physiology of, Hybridization and early development: ENVIRONMENT AND EARLY DEVELOPMENT (including) Effect of environmental constituents, Temperature and the developmental rate, Heteroploidy from low temperatures, Effect of pressure, Effect of gravity, Effect of thyroid and iodine: OPERATIVE PROCEDURES (including) Cell movements and vital staining, Parabiosis and Telobiosis, Chimeras, Culturing of isolated tissues, Limb-field and other field operations, Organizer and development: INVERTEBRATE MATERIAL (including) Artemia, Daphnia, Tubifex, Enchytrea, Introduction to experimental method using Planaria: FISH MATERIAL: CHICK MATERIAL.

Following the above body of the work are pages 264-267 on Biophotography, pages 268-275 on equipment, companies selling the same, solutions and reagents, instruments, etc. Pages 277-302 are occupied by a glossary of embryological terms, one of the most extensive we have seen.

Having reviewed many works on microtechnique in our own teaching we are very favorably impressed with this laboratory guide. It is crowded from cover to cover with information of great value to experimentalists on vertebrate material and has many procedures which could be of use to experimenters on insect eggs but more particularly on insect larvae and pupae. The insect egg itself offers extreme difficulties because of its very protective hard chorion.

Professor Roberts Rugh is teacher of embryology at the Washington Square College (New York) of New York University. He is a graduate of Oberlin College (A.B. and A.M.) and of Columbia University (Ph.D.). This handy volume represents experience.—C. H. K.

LM

A NEW GENUS (PLUMERELLA) AND A NEW SPECIES OF GRASS FEEDING LEAFHOPPER FROM MEXICO

Dwight M. DeLong,
Ohio State University,
Columbus, Ohio

The specimens from which the following genus and species are described seem to live at a quite definite and limited ecological range. They occur only in the alpine flora at altitudes of 10,000 to 10,500 feet in the tropical portion of the Sierra Madre Mountains. A large series of specimens were collected from tall, thick tufts of bunch grass growing under the pines and firs on the slopes at the tops of the range at Rio Frio, some 30 miles from Mexico City. Extensive collecting at different altitudes and in many associations indicates that this species occurs only at this altitude and under these specific conditions.

Lm

p. 498)

Genus **Plumerella** N. G.

In general appearance resembling *Draeculacephala* and closely related to it. Vertex more elongate and tubular, the upper surface is convexly rounded from the lateral margins, not depressed, evenly sloping from anterior portion of pronotum to blunt apex. Ocelli minute, on posterior portion of vertex, three-fourths the distance from apex to pronotum Face long, contour almost straight in profile or slightly concave from apex of vertex to clypeus. Body elongate, narrow, elytra without reticulate cross veins at apex.

Genotype, *alpina*, n. sp.

At the present time specimens from which this genus is described are known only from Mexico. Dr. C. C. Plummer assisted in collecting the original series, as well as many other interesting species, and I take pleasure in naming this genus in his honor.

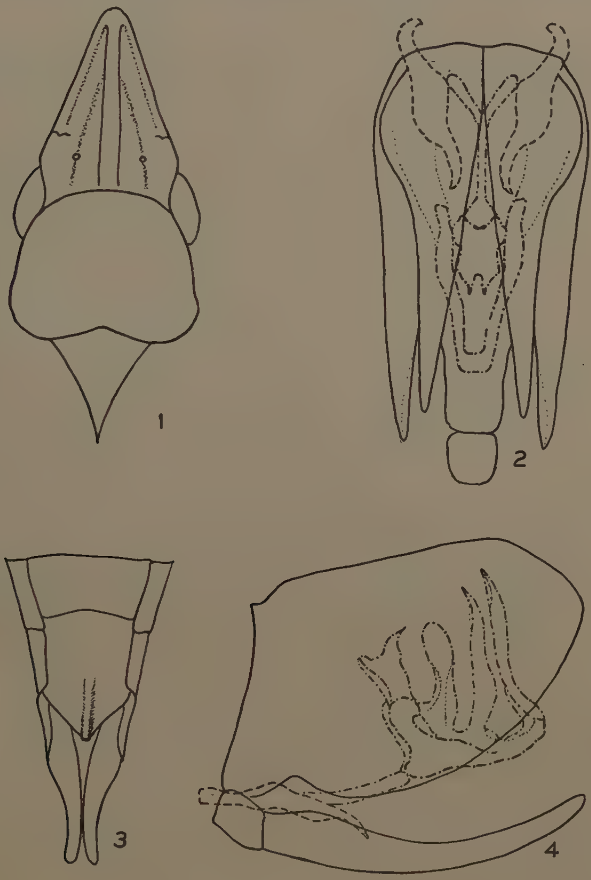
Plummerella alpina n. sp.

(Figs. 1–4)

Superficially resembling a "long nosed" species of *Draeculacephala*. Length, 7.5–9 mm.

Vertex strongly produced, apex blunt, about one-fourth longer on middle than basal width between eyes. Convexly rounded between lateral margins. Margin thick at apex. Ocelli minute, distant from eyes and more than three-fourths the distance from apex to pronotum. Pronotum deeply, broadly notched at middle on posterior margin.

Color.—Dark green, yellow and marked with black. Vertex yellowish, central half sometimes rusty in color. A pair of proximal narrow black longitudinal lines on middle. In well marked specimens with a pair of longitudinal, divergent lines from apex which are often broken and pass through the ocelli. Pronotum yellow to dark green, usually with black longitudinal lines at margin, a longitudinal line at middle, and one on outer margin either side of darker median color band. Scutellum yellow, a pair of small, proximal black dashes just behind margin of pronotum and a proximal pair on disc. Elytra dark green, veins paler but not conspicuous. Face varying from entirely black in the males with a few pale areas on clypeus and lorae, to a broad, black elongate band in females, extending from apex to tip of clypeus. Marginal line on vertex and a few arcs just beneath dark brown to black.



Plummerella alpina. 1. Dorsal view of head and pronotum. 2. Ventral view of male genitalia. 3. Ventral view of apical portion of female abdomen. 4. Lateral view of male genitalia showing aedeagus.

Genitalia.—Female last ventral segment roundedly produced posteriorly and distinctly keeled on middle at apex. Male plates long and slender, triangular with long alternate apices which almost reach the apices of the pygofers. Male styles with apical fourth narrowed, central half broad, and basal fourth narrowed with tip curved inwardly. The aedeagus is a complicated structure with a series of processes extending dorsally from the ventral base. At the anterior end is a pair of short basal processes, between which is another process which is divided apically into two divergent portions which are broadened at their apices; just posterior to this is a tubular structure which is broadly rounded at apex. The two processes which are posterior to the tube are longer and have pointed apical tips, the posterior of the two being slightly longer.

Holotype male, allotype female and male and female paratypes from Rio Frio, Mexico, D. F., October 7 and 18, 1941, collected by C. C. Plummer, J. S. Caldwell, E. E. Good and the author, in the author's collection, and paratypes in the U. S. National Museum collection. A series of specimens are also at hand labeled "Mexico" and kindly loaned for study by Dr. Edward S. Ross, Assistant Curator of Insects at the California Academy of Sciences. These have been made paratypes and are deposited in the insect collection of that institution.

AN ILLUSTRATED CATALOGUE OF THE PALEARCTIC MELITAEA (LEP. RHOPALOCERA), by L. G. HIGGINS, MA., F.R.C.S. One hundred ninety pages, 215 text figures, 7 maps and 16 plates of 12 butterflies each, in color, 1941. 7 x 10¼ inches, paper bound. Published in the Transactions, ROYAL ENTOMOLOGICAL SOCIETY OF LONDON, Vol. 91, Part 7. Pp. 175–365. Price 4£–0s–0d.

We wish to call attention to the beautifully illustrated monograph of the Melitaea butterflies by L. G. Higgins which is just off the press in London. We wish to remind our readers that this very night, parts of Singapore are being cleared for the final fight before that world citadel. The dogged determination of the English to carry problems through to a monographic finish despite all opposition and all necessary sacrifice may yet bring comfortable peace. But we wander.

The text figures are line drawings of male genitalia. The plates in color show the body and upper surface of the left wings with the under surface of the left wings reversed and in place of the right wings. One hundred ninety-two such colored drawings made by the artist, Miss Dorothy Fitchew, are used. To the average lover of butterflies the colored plates are the thrilling part of the work. To the specialist the careful work done in allocating all the named varieties and aberrations to the proper species, their distribution, whether they are first or second generation forms, are confined to one sex or occur in both sexes, are the points of interest.

The author is a famous British medical man, a Fellow of the Royal College of Surgeons. He is a Fellow of the Royal Entomological Society. His recreations are entomology and music. His home is in Woking, Surrey.

As a final nudge we wish to point out that this and other similar publications of the Royal Entomological Society are made possible by the annual fee of two guineas (about $10.00). The publications of our society depend on an annual fee of $4.00.—C. H. K.

AGELENIDAE OF THE GENERA HOLOLENA, NOVALENA, RUALENA, AND MELPOMENE

Ralph V. Chamberlin and Wilton Ivie,
University of Utah,
Salt Lake City, Utah

In this paper we present the second part of a revisional study of the Agelenid spiders belonging to the group Ageleneae. The first part appeared in the Annals of the Entomological Society of America, 1941, Vol. 34. In the present paper, we treat the rest of the known North American genera of this group, consisting of *Hololena* Chamberlin and Gertsch, *Novalena*, new, *Rualena*, new, and *Melpomene* Cambridge.

Besides the specimens in the University of Utah collection, we had accesss to a considerable number of specimens from the American Museum of Natural History, kindly loaned to us by Dr. Willis J. Gertsch. Among the latter, were several species which Dr. Gertsch had recognized and labeled as new, but permitted us to use in this revision; these were *Hololena pearcei*, *Rualena alleni* and *cockerelli*, and *Melpomene plesia* and *chiricana*.

We have followed the method of presentation used in the earlier paper. The present location of the specimens referred to is given as near as we know it. The abbreviations used are these: A. M.—American Museum, U. U.—University of Utah, F. M.—Field Museum, M. C. Z.—Museum of Comparative Zoology, Harvard.

While this work is far from complete, it is an attempt to compile what is known of this group, with the hope that it will serve as a basis for future workers in this field.

Genus **Hololena** Chamberlin and Gertsch

Agelena (in part) various authors.
Agelena (subgenus *Hololena*) Chamberlin and Gertsch, Journ. Ent. & Zool., 1929, 21: 105.
Hololena Chamberlin and Ivie, 1935, Bull. Univ. Utah, 26 (4): 31 [Biol. ser. 2 (8): 31].

Typical Color.—Carapace light yellowish brown; with a narrow black seam on each side; a broad brown band along each side above, extending from near the base to the anterior eye row, becoming narrowed on head part; a broad median light band. Chelicerae reddish brown. Endites orange; labium dusky orange; both with narrow whitish tips. Sternum yellowish, with the side margins faintly shaded.

Legs light brownish yellow, with faint dusky annuli. Abdomen dark gray on the sides above, becoming lighter below; with a wide, pale gray, median band above, extending the full length, enclosing a faint dusky lanceolate mark on the basal part, and a faint herringbone pattern on posterior part. Sides specked and streaked; venter pale, with a broken black line along each side, and the whole more or less specked or mottled with darker gray. Spinnerets brownish or dusky orange. Epigastric region pale gray; epigynum reddish brown or yellowish brown.

Typical Structure.—Structure essentially typical for that of the Ageleneae group as a whole. Eyes about equal; order of size A.S., A.M., P.S., P.M.; P.M. eyes about three-fourths of a diameter apart, about one diameter from the side eyes. Chelicerae with two teeth on the hind margin of the fang groove. Tibia-patella IV longer than tibia-patella I, and longer than the carapace, except occasionally in females, where the two are about equal. Spines essentially typcial. Apical segment of hind spinnerets distinctly shorter than the basal segment.

Epigynum typically a rounded basin-like depression, sometimes more or less divided by a median ridge. The openings are in the posterior lateral part of the depression. Just posterior to the depression, or to the side of it, is a pair of short, widely separated spurs. The posterior median sclerite is well developed, extending deep into the genital furrow; the lateral sclerites are well developed, on the surface, but do not extend into the genital furrow, and are fused to the median sclerite.

Palpus.—Femur and patella unmodified. Tibia highly sculptured on the ectal side; there is a flat, pointed, apical process, and a basal lobe, as seen from the ventral view; back of these, on the dorso-ectal aspect, is a deep excavation. The apical process of the tibia has a tooth-like subprocess on the ectal side. The basal lobe consists of a more or less rounded lobe, which bears hairs, and a smooth tongue-like process. The cymbium is short, and the apical process is not extended as in *Agelenopsis* and *Tortolena*. The tegulum is simple, without chitinized extensions. The median apophysis is a small sclerotized, husk-shaped structure. The conductor has an apical process, variously shaped in the different species, and an ectal tail piece, which is largely concealed. The embolus is a short, simple, stylus-like structure, arising on the mesal side and extending medially and distally; usually somewhat twisted. The tip of the embolus is not held by the conductor, but is contained in a large folded fulcrum, which is thin and usually transparent, and arises from near the middle of the ventral side.

Genotype: *Hololena mimoides* (Chamberlin)

This genus consists of a large number of closely related species, found in the western United States and extending into northwestern Mexico. They are very similar in color, and no separation of species is possible on this basis. The epigyna of the females are all of the same general pattern, and in some cases, separation of species on this character alone is difficult, especially since there is often considerable variation of proportions within the species. Size is of little value, since this shows a very wide range, especially among the females of each species; furthermore, there is not much variation in size between the species, this remaining quite consistently between 7 and 11 mm. for length. In the males, the palpus contains the only reliable characters for species determination. The apical process of the conductor and the basal lobe of the tibia, furnishing the best differences, with the median apophysis and the fulcrum also being of some value.

Hololena mimoides (Chamberlin)

(Figs. 1, 2)

Agelena mimoides Chamberlin, 1919, Ann. Ent. Soc. Amer., 12: 256, Pl. 19, ff. 5–6.
Agelena (*Hololena*) *mimoides* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 106, Pl. 2, ff. 16–18.

Color normally typical; some specimens paler, with the dark markings faded. Structure typical. Palpus and epigynum distinct.

Measurements:	♂	♀
Length	10.20 mm.	10.40 mm.
Carapace:		
Length	4.70	4.70
Width	3.00	3.30
Tibia-patella:		
I	5.20	4.40
IV	5.75	5.00

Type locality: About W 112° 15′ : N 38° 58′, Filmore Canyon, Utah; ♂ holotype, ♀ allotype. (M. C. Z.)

Known Localities:

109.38 ♀—Moab, Utah; April 19, 1928; J. W. Gertsch. (U. U.)
109.37 ♀—Devil's Canyon, Utah; April 18, 1928; W. J. Gertsch. (U. U.)
111.34 ♀—Oak Canyon, 20 mi. South of Flagstaff, Arizona; April 12, 1935; Wilton Ivie. (U. U.)
112.38 ♀ ♂—(Type locality).
112.37 ♂ 7♀—Zion Park, Utah. (A. M., U. U.)
113.37 ♀ ♂—St. George, Utah; 1925, 1926; A. M. Woodbury. (U. U.)
" " ♀—Pintura, Utah; April 15, 1932; Wilton Ivie. (U. U.)
" " ♀—Pine Valley, Utah; June 12, 1934; W. Ivie and H. Rasmussen. (U. U.)

Hololena madera Chamberlin and Ivie, new species

(Figs. 3, 4)

Color and structure typical. Close to *mimoides*; differing in details of the palpus and epigynum.

Measurements:	♂	♀
Length	11.00 mm.	10.80 mm.
Carapace:		
Length	6.00	5.50
Width	4.00	3.50
Tibia-patella:		
I	6.00	4.90
IV	6.70	5.60

Type locality: W 110° 55′ : N 31° 40′, Madera Canyon, Santa Rita Mts., Arizona; ♂ holotype, ♀ allotype, ♂s ♀s paratypes; September 10, 1941; Wilton Ivie collector.

Hololena atypica Chamberlin and Ivie, new species

(Fig. 5)

Color essentially typical; venter of abdomen not specked; median basal lanceolate mark above moderately distinct. Structure typical, except for the distinctly different form of epigynum.

Measurements:	♀ Holotype
Length	8.00 mm.
Carapace:	
Length	4.00
Width	2.60
Tibia-patella:	
I	3.50
IV	4.00

Type locality: W 105° 16′ : N 40° 2′, Boulder, Colorado; ♀ holotype; May 13, 1937; N. B. Wigutuff collector. (A. M.)

Hololena hola (Chamberlin and Gertsch)

(Figs. 6, 7, 8)

Agelena hola Chamberlin and Gertsch, 1928, Proc. Biol. Soc. Wash., 41: 183. (In part: Holotype, not paratypes.)

Agelena (*Hololena*) *hola* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 106.

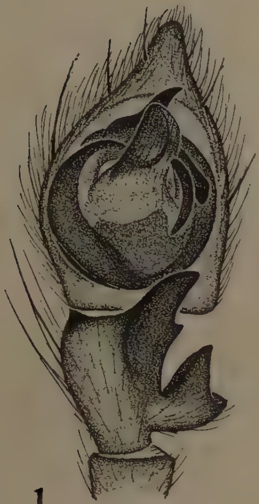
Color and structure typical, with distinct differences in the palpus and epigynum. The epigynum has a wide opening, into which the posterior margin extends; this margin is bilobate, and in some specimens is very asymmetrical. The palpus has a heavy apical process on the conductor, which is flared at the tip.

Measurements:	♂	♀
Length	8.80 mm.	8.00 mm.
Carapace:		
Length	4.30	4.00
Width	3.00	2.70
Tibia-patella:		
I	4.90	3.80
IV	5.50	4.25

Type locality*:* W 109° 8′ : N 37° 38′, Verdure, Utah; ♀ holotype; April 18, 1928; W. J. Gertsch collector. (U. U.)

Explanation of Plate I

Hololena mimoides (Chamberlin). 1. Left palpus, ventral view. 2. Epigynum. *Hololena madera* Chamberlin and Ivie, new species. 3. Left palpus, ventral view. 4. Epigynum. *Hololena atypica* Chamberlin and Ivie, n. sp. 5. Epigynum. *Hololena hola* (Chamberlin and Gertsch). 6. Left palpus, ventral view. 7. Tip of conductor of left palpus, dorso-ectal view. 8. Epigynum. *Hololena hopi* Chamberlin and Ivie, n. sp. 9. Epigynum. *Hololena oquirrhensis* (Chamberlin and Gertsch). 10. Epigynum.



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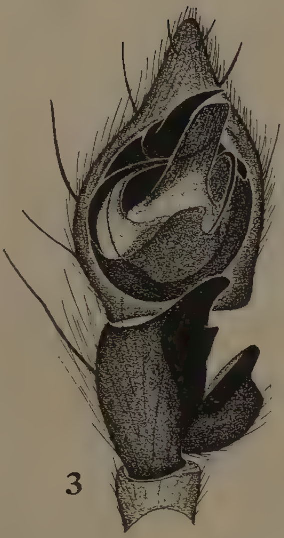

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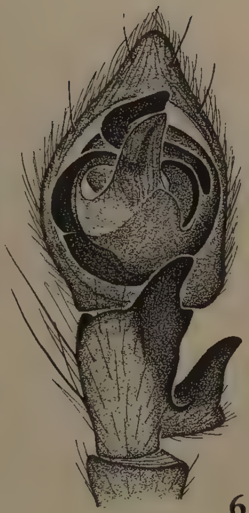

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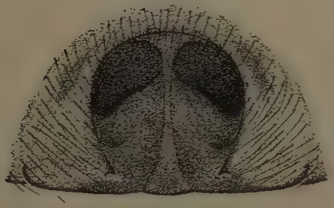

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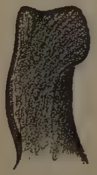

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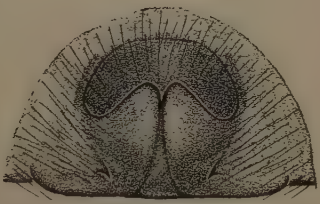

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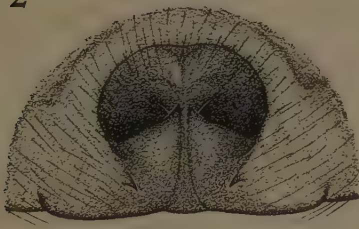

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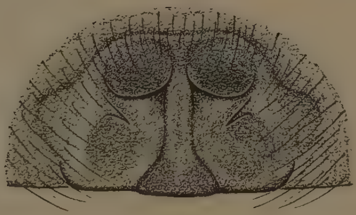

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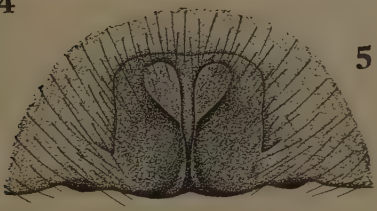

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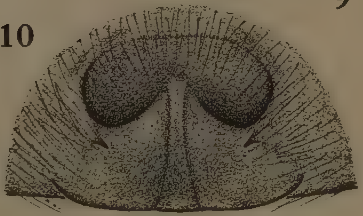

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Known Localities:

104.39 ♀—Parker, Colorado; October 10–20, 1934; Chas. A. Wagner. (A. M.)
105.40 2♀—Boulder, Colorado; March 9, 1939, and April 28, 1935; H. G. Rodeck. (U. U.) (A. M.)
105.32 ♂♀—Camp Mary White, New Mexico; August, 1934; Stanley Mulaik. (A. M.)
108.35 ♂s ♀s—Bluewater Lake, New Mexico; September 4, 1941; Wilton Ivie. (U. U.)
108.37 ♀—10 mi. No. Cortez, Colorado; June 17, 1934; Wilton Ivie. (U. U.)
109.37 ♀—(Type locality.)
" " 2♂ ♀—W. Monticello, Utah; September 8, 1933; Wilton Ivie. (U. U.)
109.32 ♂—Graham Mt., Arizona. (A. M.)

Hololena hopi Chamberlin and Ivie, new species

(Fig. 9)

Color essentially typical. Sternum shaded and specked with dusky; very little in the middle, more on the sides. The annuli on the legs fairly distinct below, fainter above. Venter of abdomen distinctly specked.

Structure typical, except the epigynum, which is distinct, as illustrated in Fig. 9.

Measurements:	♀ Holotype
Length	8.50 mm.
Carapace:	
Length	3.55
Width	2.50
Tibia-patella:	
I	3.20
IV	3.65

Type locality: W 112° 35′ : N 34° 24′, About 15 mi. S. W. Prescott, Arizona; ♀ holotype; April 8, 1935; Wilton Ivie collector. (U. U.)

Hololena oquirrhensis (Chamberlin and Gertsch)

(Figs. 10, 11)

Agelena oquirrhensis Chamberlin and Gertsch, 1930, Proc. Biol. Soc. Wash., 43: 142, Pl. 5, fig. 27.

Color and structure typical. Palpus and epigynum as figured.

Measurements:	♂	♀
Length	8.70 mm.	9.30 mm.
Carapace:		
Length	4.10	4.30
Width	2.85	2.90
Tibia-patella:		
I	4.65	4.15
IV	5.00	4.65

Type locality: W 112° 7′ : N 40° 32′, Butterfield Canyon, Oquirrh Mts., Utah; ♂ holotype, ♀ allotype, ♀ paratype; May 25, 1929; Ralph Goodwin collector. (U. U.)

Known Localities:

111.40 ♂ ♀s—Wasatch Mts., Utah, several localities. (U. U.)
112.40 ♂ 2♀—(Type locality.)
112.36 4♀—Jacob Lake, Arizona; June 14, 1934; W. Ivie and H. Rasmussen. (U. U.)
114.42 ♀—Twin Falls, Idaho; April 16, 1932; A. C. Cole. (A. M.)

Hololena nevada (Chamberlin and Gertsch)

(Figs. 12–14)

Agelena (*Hololena*) *nevada* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 107, Pl. 2, ff. 22–24.

Color and structure typical, with distinctive differences in the palpus and epigynum. The epigynum has a wide depression similar to that of *hola*, but does not have the posterior margin of the depression bilobate. The male palpus has the apical tip of the conductor heavy, with a deep notch in the end.

Measurements	♂	♀
Length	10.00 mm.	10.00 mm.
Carapace:		
Length	4.70	4.40
Width	3.10	2.93
Tibia-patella:		
I	5.20	4.53
IV	6.00	5.45

Type locality: W 119° : N 39°, Pyramid Lake, Nevada; ♂ holotype (taken from the stomach of a lizard and badly damaged). (U. U.)

Known Localities:

109.38 ♀—Colorado River, 5 mi. N. E. Moab, Utah; May 13, 1933; W. Ivie. (U. U.)
110.39 2♂ 2♀—Price, Utah; 1937; Ross Hardy. (A. M., U. U.)
112.38 2♀—Richfield, Utah; May 17, 1930; W. J. Gertsch. (A. M., U. U.)
" " ♀—Beaver Canyon, Utah; June 7, 1934; W. Ivie and H. Rasmussen. (U. U.)
119.39 ♂ (Type locality.)

Hololena furcata (Chamberlin and Gertsch)

(Figs. 15, 16)

Agelena (*Hololena*) *furcata* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 107, Pl. 2, 19–21.

Color and structure typical. Epigynum close to that of *nevada*. Palpus with apical process of conductor more deeply notched than that of *nevada*, and with the distal fork longer than the posterior.

Measurements:	♂ Holotype	♀ Allotype
Length	8.50 mm.	8.00 mm.
Carapace:		
Length	4.30	4.00
Width	2.80	2.60
Tibia-patella:		
I	4.00	3.45
IV	4.35	3.90

Type locality: W 122° 15′ : N 37° 50′, Berkley, California; ♂ holotype, ♀ allotype, ♂ paratype; J. C. Chamberlin collector. (U. U.)

Known Localities:

121.37 2♀—Castro Valley, Alameda Co., California; March, 1941; W. M. Pearce. (A. M.)
122.37 2♂ ♀—(Type locality.)
" " ♀—Contra Costa Co., California; April 2, 1941; W. M. Pearce. (A. M.)
" " ♂—San Francisco, California. (A. M.)

Hololena frianta Chamberlin and Ivie, new species

(Figs. 17, 21)

Color and structure essentially typical. The epigynum has a very large depression. The male palpus is distinct; the apical process of the conductor is very wide and dentate at the tip.

Measurements:	♂ Holotype	♀ Allotype
Length	8.00 mm.	8.00 mm.
Carapace:		
Length	4.30	4.00
Width	2.80	2.45
Tibia-patella:		
I	4.40	3.80
IV	5.00	4.20

Type locality: W 119° 45′ : N 36° 60′, Friant, California; ♂ holotype, ♀ allotype, ♀ paratype, March, 1913; R. V. Chamberlin collector. (U. U.)

Known Localities:

119.37 2♂—Wawona Camp, Yosemite Park, California; September 17, 1941; Wilton Ivie. (U. U., A. M.)
119.36 ♂ 2♂—(Type locality.)

Hololena pacifica (Banks)

(Figs. 18, 22)

Agelena pacifica Banks, 1896, Journ. N. Y. Ent. Soc., 4: 89.
Agelena curta McCook (in part), Petrunkevitch, 1911, Catalogue, p. 527.
Agelena (*Hololena*) *perita* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 107, Pl. 3, ff. 29–30.
Hololena pacifica Chamberlin and Ivie, 1941, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Color and structure typical. The epigynum has a large depression very similar to that of *frianta*, but has the two spurs closer together than in that species. The male palpus is distinctly different.

Measurements:	♂	♀
Length	10.00 mm.	11.20 mm.
Carapace:		
Length	5.30	5.10
Width	3.50	3.20
Tibia-patella:		
I	5.15	4.60
IV	6.00	5.00

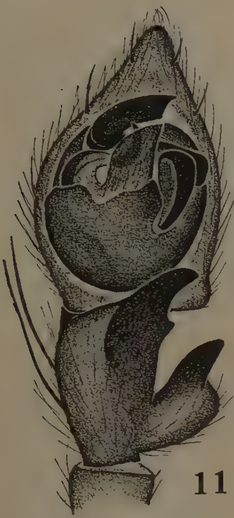
Type locality: W 122° : N 37°, Palo Alto, and Black Mt., California; 3 ♀s. (M. C. Z.)

Known Localities:

122.37 3♀—(Type locality.)
" " ♂s ♀s—Many localities. (U. U., A. M.)

EXPLANATION OF PLATE II

Hololena oquirrhensis (Chamberlin and Gertsch). 11. Left palpus, ventral view. *Hololena nevada* (Chamberlin and Gertsch). 12. Left palpus, ventral view. 13. Tip of conductor of left palpus, posterio-ectal view. 14. Epigynum. *Hololena furcata* (Chamberlin and Gertsch). 15. Left palpus, ventral view. 16. Epigynum. *Hololena frianta* Chamberlin and Ivie, n. sp. 17. Epigynum. *Hololena pacifica* (Banks). 18. Epigynum. *Hololena curta* (McCook). 19. Epigynum. *Hololena tentativa* (Chamberlin and Gertsch). 20. Epigynum.



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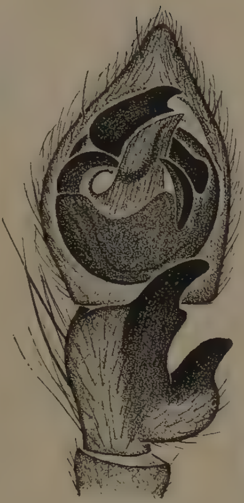

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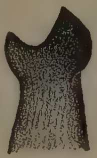

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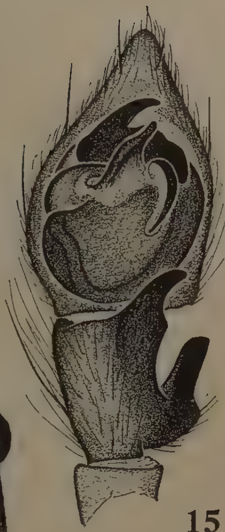

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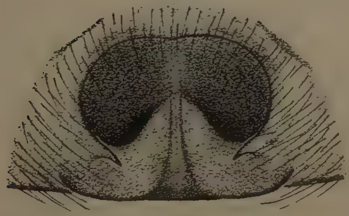

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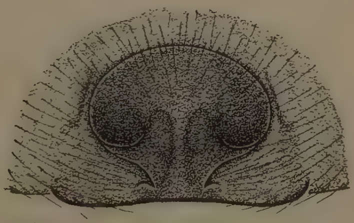

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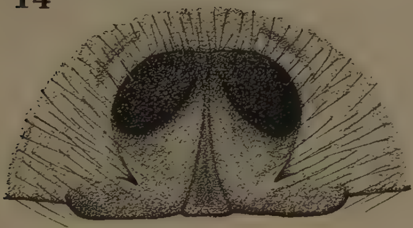

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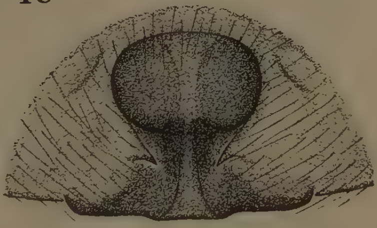

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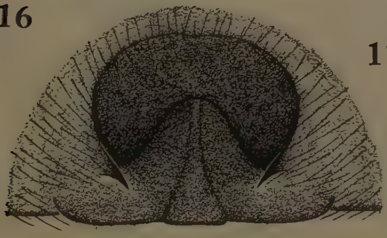

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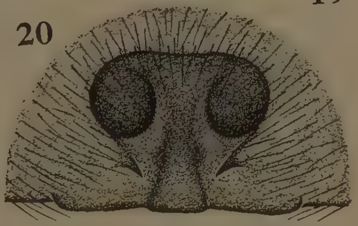

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Hololena curta (McCook)

(Figs. 19, 23)

Agelena curta McCook, 1893, American Spiders, Vol. 3, Pl. 29, ff. 2–3.
Agelena curta Petrunkevitch, 1911, Catalogue, p. 527.
Agelena (Hololena) curta Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 21: 106.
Hololena tentativa Chamberlin and Ivie, 1941, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Color and structure typical; size above average.

Measurements:	♂	♀
Length	10.50 mm.	12.40 mm.
Carapace:		
Length	5.40	5.30
Width	3.50	3.50
Tibia-patella:		
I	5.20	4.85
IV	5.60	5.30

Type locality: "California."

Known Localities:

118.34 ♂s ♀s—Los Angeles, Santa Monica, etc., California. (U. U., F. M., A. M.)
119.34 ♀—Santa Barbara, California; August 8, 1934; J. R. Douglas. (U. U.)

We are not certain that this species is the same as McCook's specimens, but it is one of the more probable species. Anyway, it may be so regarded, pending the resurrection of McCook's type specimens. Should his specimens not be found, we propose that this species be recognized as *curta*, and that a male and female from Los Angeles and Santa Monica respectively, tentatively labeled as neotypes and placed in the University of Utah collection, become the types.

Hololena tentativa (Chamberlin and Gertsch)

(Figs. 20, 27)

Agelena pacifica, var., Chamberlin, 1920, Journ. Ent. and Zool., Vol. 12, Pl. 3, fig. 6.
Agelena (Hololena) tentativa Chamberlin and Gertsch, 1929, Ibid., 21: 6, Pl. 3, ff. 31–32.
Agelena (Hololena) curta, id., Ibid., Pl. 3, f. 33.

Closely resemble *curta* in color and structure. The depression of the epigynum is wider anteriorly than in *curta*. The male palpus has the tongue-like process on the basal lobe of the tibia narrower than in *curta*, and the tip of the apical process of the conductor less truncate.

Measurements:	♂	♀ (large)
Length	10.00 mm.	13.50 mm.
Carapace:		
Length	5.50	6.70
Width	3.50	4.40
Tibia-patella:		
I	5.20	5.40
IV	5.80	5.90

Type locality: W 117° 45′ : N 34° 4′, Claremont, California; ♂ holotype, ♀ allotype; R. V. Chamberlin collector. (U. U.)

Known Localities:

117.34	♂, ♀s—(Type locality.)
118.34	♂—Los Angeles, California. (A. M.)
" "	♀—Los Angeles, California. (U. U.)

Hololena barbarana Chamberlin and Ivie, new species

(Fig. 37)

Color and structure typical. Close to *curta*, but differs in that the depression of the epigynum is smaller and farther removed from the genital furrow; the spurs are prominent.

Measurements:	♀ Holotype
Length	11.70 mm.
Carapace:	
Length	5.40
Width	3.60
Tibia-patella:	
I	4.80
IV	5.20

Type locality: W 119° : N 34°, Santa Cruz Island, California; ♀ holotype; March-April 1913; R. V. Chamberlin collector. (U. U.)

Known Localities:

118.34	3 ♀—Fillmore, California; November 6, 1927; O. F. Young. (U. U., A. M.)
119.34	♀ (Type locality.)

Hololena santana Chamberlin and Ivie, new species

(Figs. 24–26)

Color and structure typical. Close to *tentativa*, with minor differences in the epigynum and palpus. The epigynum is distinctive, but the palpus is very close to *tentativa*, differing slightly in the shape of the tongue-like process on the basal lobe of the tibia.

Measurements:	♂ Allotype	♀ Holotype
Length	11.00 mm.	11.00 mm.
Carapace:		
Length	5.70	5.60
Width	3.80	3.80
Tibia-patella:		
I	5.30	5.30
IV	5.90	5.80

Type locality: W 117° 37′ : N 33° 41′, Irvine, California; ♀ holotype ♂ allotype, July 17, 1931; Wilton Ivie collector (U. U.) ♀ paratype, Monrovia Canyon, California; July 26, 1931; R. V. Chamberlin collector (U. U.)

Hololena dana Chamberlin and Ivie, new species

(Figs. 28–29)

Color and structure typical. Close to *curta*, *tentativa*, and *santana* but distinguishable by minor differences in the palpus and epigynum.

In the palpus, the median apophysis is slender and more pointed distally than in the other three species.

Measurements:	♂	♀
Length	8.70 mm.	11.20 mm.
Carapace:		
Length	4.40	6.00
Width	3.20	3.70
Tibia-patella:		
I	4.50	5.20
IV	5.20	5.60

Type locality: W 117° 50′ : N 33° 33′, Laguna Beach, California; ♂ holotype, ♀ allotype, ♀s paratypes; July 29, 1931; Wilton Ivie. ♀s ♂ paratypes; December 28, 1932; W. Ivie. (U. U.)

Known Localities:

117.33 2♂ ♀s—(Type locality).
117.32 ♀—Mouth of San Diego River, California; July 11, 1931; Wilton Ivie. (U. U.)

Hololena septata Chamberlin and Ivie, new species

(Fig. 36)

Color essentially typical; the annuli on the legs wide, and the median dorsal band of the abdomen shaded with dusky. The epigynum resembles that of *dana*, except that there is a distinct median septum.

Measurements:	♀ Holotype
Length	7.20 mm.
Carapace:	
Length	3.50
Width	2.50
Tibia-patella:	
I	3.30
IV	3.60

Type locality: W 116° 32′ : N 32° 50′, East of Pine Valley, California; ♀ holotype; collected in immature state September 13, 1941, matured October 6, 1941; Wilton Ivie collector. (U. U.)

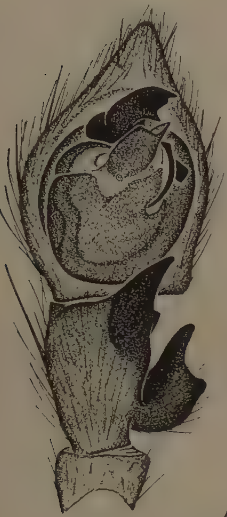
Hololena monterea Chamberlin and Ivie, new species

(Figs. 32–33)

Color and structure typical. The palpus and epigynum distinctive. The epigynum has a broad opening, with the spurs situated close to the posterior margin.

EXPLANATION OF PLATE III

Hololena frianta Chamberlin and Ivie, n. sp. 21. Left palpus, ventral view. *Hololena pacifica* (Banks). 22. Left palpus, ventral view. *Hololena curta* (McCook). 23. Left palpus, ventral view. *Hololena santana* Chamberlin and Ivie, n. sp. 24. Tip of left palpus, ventral view. 25. Tibia of left palpus, ventral view. 26. Epigynum. *Hololena tentativa* (Chamberlin and Gertsch). 27. Left palpus, ventral view. *Hololena dana* Chamberlin and Ivie, n. sp. 28. Left palpus, ventral view. 29. Epigynum.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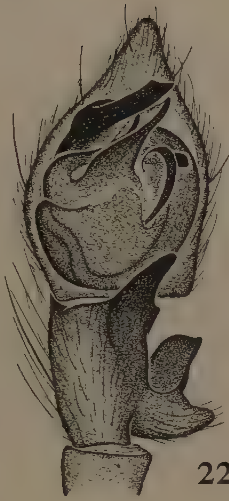
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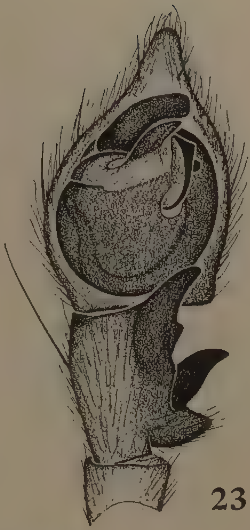
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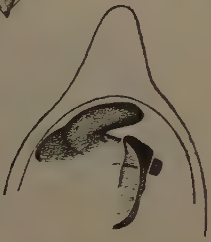
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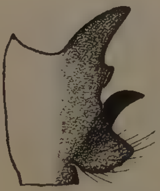
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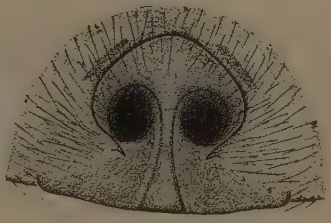
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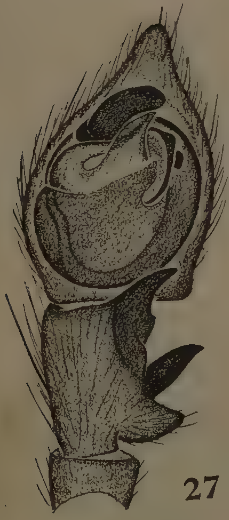
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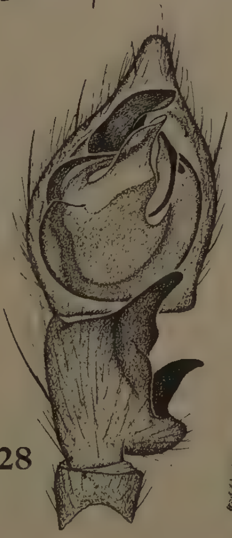
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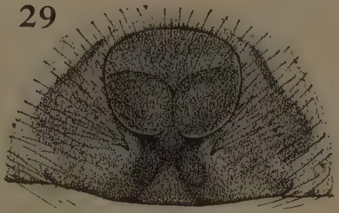
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Measurements:	♂ Holotype	♀ Allotype
Length	8.50 mm.	10.70 mm.
Carapace:		
Length	4.40	5.40
Width	3.00	3.30
Tibia-patella:		
I	4.40	4.45
IV	4.70	4.80

Type locality: W 121° 55′ : N 36° 38′, Pacific Grove, California; ♂ holotype, August 18, 1931; ♀ allotype, September 1, 1937; Wilton Ivie collector. (U. U.) 3 ♀ paratypes from near Monterey, California. (A. M.)

Hololena aduma Chamberlin and Ivie, new species

(Fig. 38)

Color and structure typical. Distinguishable in the female by the form of the epigynum. The depression is deep, with a sharp ridge across front extending around sides to the posterior point, formed by the spurs, which are more obtuse than usual and situated near the genital furrow.

Measurements:	♀ Holotype
Length	8.00 mm.
Carapace:	
Length	3.90
Width	2.70
Tibia-patella:	
I	3.40
IV	3.85

Type locality: W 121° 53′ : N 36° 35′, Monterey, California; ♀ holotype, ♀ paratype; March, 1936; Afton Williams collector. (U. U.)

Hololena pearcei Chamberlin and Ivie, new species

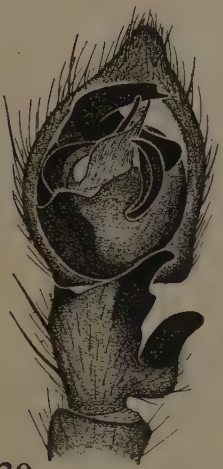
(Figs. 30-31)

Color typical, although sometimes paler than usual, especially in the male. The male palpus is distinct, although close to that of *sula*; the differences are shown in the figures. The epigynum bears resemblance to those of *furcata* and *sula*, both of which occur in the same region. The posterior margin does not extend as far into the depression as in *furcata*; the depression is slightly narrower than in *sula*.

Measurements:	♂	♀
Length	10.60 mm.	11.30 mm.
Carapace:		
Length	5.40	5.90
Width	3.50	3.70
Tibia-patella:		
I	5.30	4.60
IV	5.75	5.10

EXPLANATION OF PLATE IV

Hololena percei Chamberlin and Ivie, n. sp. 30. Left palpus, ventral view. 31. Epigynum. *Hololena monterea* Chamberlin and Ivie, n. sp. 32. Left palpus, ventral view. 33. Epigynum. *Hololena sula* Chamberlin and Ivie, n. sp. 34. Left palpus, ventral view. 35. Epigynum. *Hololena septata* Chamberlin and Ivie, n. sp. 36. Epigynum. *Hololena barbarana* Chamberlin and Ivie, n. sp. 37. Epigynum. *Hololena aduma* Chamberlin and Ivie, n. sp. 38. Epigynum.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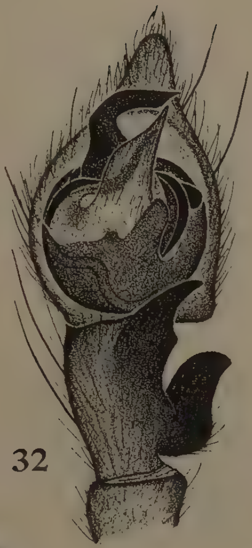
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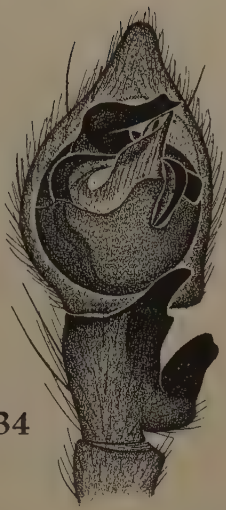
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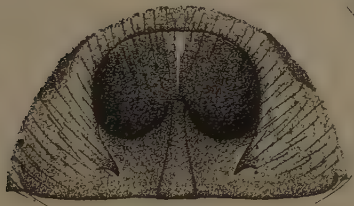
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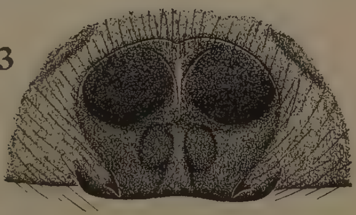
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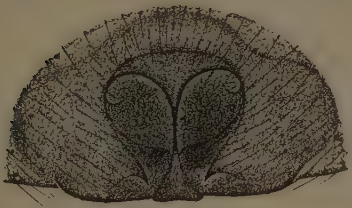
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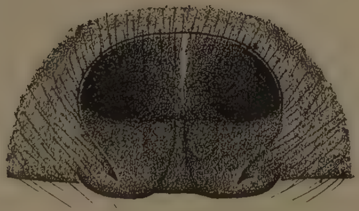
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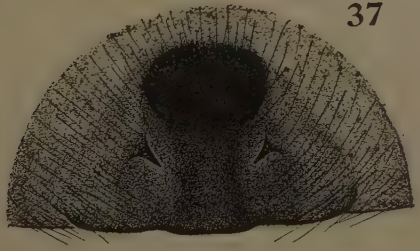
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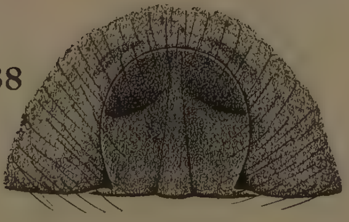
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Type locality: W 122° : N 37°, Castro Valley, California; ♂ holotype, ♀ allotype, 2 ♂ paratypes; October 23, 1938; W. M. Pearce collector. (A. M.)

Hololena sula Chamberlin and Ivie, new species

(Figs. 34–35)

Color and structure typical. Close to *pearcei*, except for minor differences in the palpus and epigynum, which are shown in the figures.

Measurements:	♂	♀
Length	8.30 mm.	9.50 mm.
Carapace:		
Length	4.20	4.30
Width	2.90	2.70
Tibia-patella:		
I	4.40	3.90
IV	4.90	4.20

Type locality: W 121° 50′ : N 37° 30′, Sunol, California; ♂ holotype, ♀ allotype; December 16, 1938; T. Aitkin collector. (A. M.)

Hololena tulareana Chamberlin and Ivie, new species

(Fig. 43)

Color and structure essentially typical. The male palpus distinctive.

Measurements:	♂ Holotype
Length	7.40 mm.
Carapace:	
Length	4.00
Width	2.60
Tibia-patella:	
I	3.90
IV	....

Type locality: W 118° : N 36°, Tulare County, California; ♂ holotype. (U. U.)

Hololena oola Chamberlin and Ivie, new species

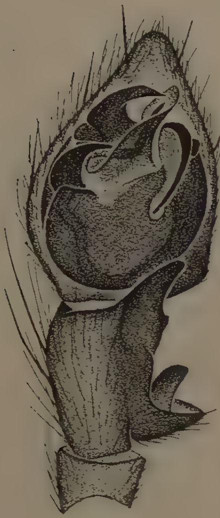
(Fig. 46)

Color and structure typical. The two openings of the epigynum are separated by a prominent septum.

Measurements:	♀ Holotype
Length	9.70 mm.
Carapace:	
Length	4.40
Width	2.95
Tibia-patella:	
I	4.00
IV	4.50

Explanation of Plate V

Hololena nedra Chamberlin and Ivie, n. sp. 39. Left palpus, ventral view. 40. Epigynum. *Hololena sidella* Chamberlin and Ivie, n. sp. 41. Left palpus, ventral view. *Hololena turba* Chamberlin and Ivie, n. sp. 42. Epigynum. *Hololena tulareana* Chamberlin and Ivie, n. sp. 43. Left palpus, ventral view. *Hololena adnexa* (Chamberlin and Gertsch). 44. Left palpus, ventral view. 45. Epigynum. *Hololena oola* Chamberlin and Ivie, n. sp. 46. Epigynum.



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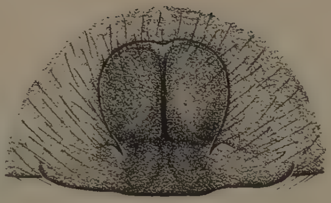

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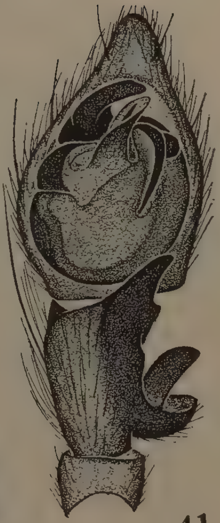

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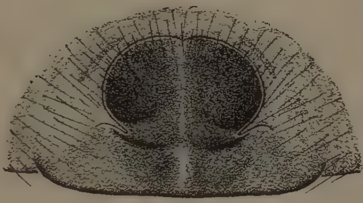

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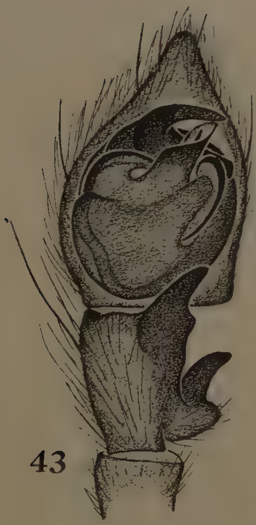

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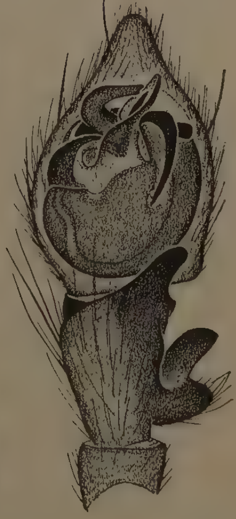

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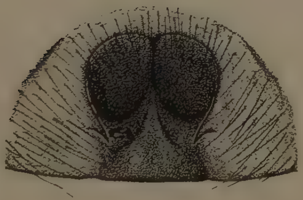

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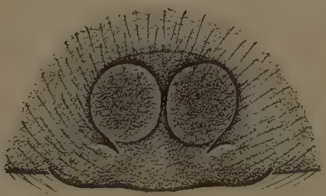

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Type locality: W 119° 44′ : N 36° 46′, 4 mi. East of Fresno, California; ♀ holotype; December 26, 1922; C. D. Duncan collector. (U. U.)

Hololena adnexa (Chamberlin and Gertsch)

(Figs. 44–45)

Agelena (*Hololena*) *adnexa* Chamberlin and Gertsch, 1929, Journ. Ent. and Zool., 20: 108, Pl. 3, ff. 34–36.

Color and structure essentially typical; males often pale in color, with little or no markings apparent on the legs. The epigynum has a median ridge; it is not easily distinguishable from that of *nedra*. The male palpus is distinguishable by the long, flat, tongue-like process on the basal lobe of the tibia, and the slight notch in the end of the distal process of the conductor.

Measurements:	♂ Holotype	♀
Length	8.50 mm.	11.00 mm.
Carapace:		
Length	4.40	5.40
Width	3.00	3.40
Tibia-patella:		
I	4.45	4.70
IV	4.95	5.30

Type locality: W 122° 20′ : N 37° 34′, Stanford, California; ♂ holotype; J. C. Chamberlin collector. (U. U.)

Known Localities:

121.38 4♀—Solano Co., California; W. M. Pearce. (A. M.)
121.37 4♀—Clayton, California; W. M. Pearce. (A. M.)
122.37 ♂—(Type locality.)
" " ♀—Berkeley, California; April, 1931; A. M. Woodbury; allotype. (U. U.)
" " 2♂ ♀—San Francisco, California; September, 1931; Sternitzky. (A. M.)

Hololena turba Chamberlin and Ivie, new species

(Fig. 42)

Close to *adnexa* in size, color, and structure, but with a different form of epigynum. The spurs of the epigynum are anterior to the posterior rim of the depression, and are very slender.

Type locality: W 122° : N 39°, Clear Lake, California; ♀ holotype, ♀ paratype; September 9, 1938; J. C. Chamberlin collector. (U. U.)

Known Localities:

122.39 2♀—(Type locality.)
122.38 ♀—Marin County, California. (U. U.)

Hololena sidella Chamberlin and Ivie, new species

(Fig. 41)

This species is close to *adnexa*, but differs principally in the distal process on the conductor of the palpus.

Measurements:	♂ Holotype
Length	9.50 mm.
Carapace:	
Length	5.00
Width	3.30
Tibia-patella:	
I	4.80
IV	5.50

Type locality: W 119° : N. 37°, Aspen Valley, Yosemite Park, California; ♂ holotype; August 11, 1931; Wilton Ivie collector. (U. U.)

Hololena nedra Chamberlin and Ivie, new species

(Figs. 39–40)

Agelena (*Hololena*) *curta*, Exline, 1938, Univ. Wash. Publ. Biol., 9:27.

Color and structure typical. The epigynum is not readily distinguishable from that of *adnexa*. The palpus is near that of *adnexa* and *sidella*, but the tip of the distral process of the conductor is more slender and lacks a notch as in *adnexa*.

Measurements:	♂ (large)	♀ (large)	♀ (small)
Length	11.10 mm.	13.00 mm.	7.60 mm.
Carapace:			
Length	5.90	6.30	4.00
Width	3.85	4.15	2.70
Tibia-patella:			
I	5.50	5.10	3.40
IV	6.15	5.50	3.95

Type locality: W 123° 16′ : N 44° 34′, Corvallis, Oregon; ♂ holotype, ♀ allotype; September 26, 1933; J. Schuh collector. Also a male and several females collected at various dates. (A. M.)

Known Localities:

119.36 ♂ 2♀—Fresno, California; December 26, 1922; C. D. Duncan. (U. U.)
121.37 ♂—Brentwood, California; September 13, 1938; W. M. Pearce. (A. M.)
122.47 —Washington: Olympia, San Juan Is., Seattle (Exline). (M.C.Z.)
122.45 ♂ ♀—Portland, Oregon; July 25, 1935; J. M. Pierson. (A. M.)
" " 7♀—Portland, Oregon; May, 1935; J. Schuh. (A. M., U. U.)
122.38 ♀—Somona County, California; June. (A. M.)
123.45 2♂ ♀—McMinnville, Oregon; 1935; Fender. (A. M.)
" " ♀—Forest Grove, Oregon; August 6, 1929; R. V. Chamberlin. (U. U.)
123.44 2♂ 7♀—(Type locality.)
123.43 ♂—Yoncalla, Oregon; 1939; Betty McGinitie. (U. U.)

Hololena rabana Chamberlin and Ivie, new species

(Fig. 49)

This species is close to *nedra*, from which it may be readily separated by the difference in the tongue-like process on the basal lobe of the tibia of the palpus. The tip of the distal process of the conductor is sharply pointed.

Measurements:	♂ Holotype
Length	7.00 mm.
Carapace:	
Length	3.55
Width	2.60
Tibia-patella:	
I	4.20
IV	4.75

Type locality: W 122° 21′ : N 42° 6′, Pinehurst, Oregon; ♂ holotype; Sept. 9, 1935; Chamberlin and Ivie collectors. (U. U.)

Hololena parana Chamberlin and Ivie, new species

(Figs. 47–48)

Color typical. Structure similar to that of *nedra* and related species, except for minor differences in the palpus and epigynum. The epigynum resembles that of *turba*, except that the median ridge is more prominent.

Measurements:	♂ Holotype	♀ Allotype
Length	10.10 mm.	9.00 mm.
Carapace:		
Length	5.30	4.50
Width	3.40	2.95
Tibia-patella:		
I	5.00	4.10
IV	5.50	4.70

Type locality: W 119° 52′ : N 39° 32′, Reno, Nevada; ♂ holotype, ♀ allotype; January, 1940; from University of Nevada collection. (U.U.)

Hololena lassena Chamberlin and Ivie, new species

(Figs. 50–51)

Color typical, with a tendency toward more shading with gray than usual. The epigynum has a relatively small depression. The palpus has the tongue-like process on the basal lobe of the tibia very short, and the apical process of the conductor is slender and sharply pointed.

Measurements:	♂	♀ Holotype
Length	7.00 mm.	8.50 mm.
Carapace:		
Length	3.50	3.85
Width	2.47	2.40
Tibia-patella:		
I	4.10	3.65
IV	4.65	4.25

Type locality: About W 121° 30′ : N 40° 30′, Mount Lassen Park California; ♀ holotype; July 1, 1940; W. M. Pearce collector. (A. M.)

Known Localities:

120.39	♀—Peavine, California; June 8, 1940; W. M. Pearce. (A. M.)
120.40	♀—Loyalton, California; June 17, 1940; W. M. Pearce. (A. M.)
121.40	♀—(Type locality.)
" "	♀—Chester, California; June 28, 1940; W. M. Pearce. (A. M.)
" "	2♂ ♀—Hat Creek, California; September 7, 1935; Chamberlin and Ivie. (U. U.)

Hololena altura Chamberlin and Ivie, new species

(Figs. 52–53)

Color and structure typical. The epigynum resembles that of *lassena*, but the depression is larger. The palpus is close to that of

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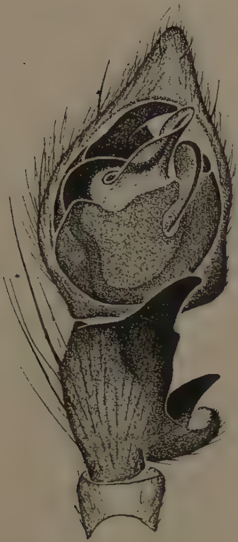
EXPLANATION OF PLATE VI

Hololena parana Chamberlin and Ivie, n. sp. 47. Left palpus, ventral view. 48. Epigynum. *Hololena rabana* Chamberlin and Ivie, n. sp. 49. Left palpus, ventral view. *Hololena lassena* Chamberlin and Ivie, n. sp. 50. Left palpus, ventral view. 51. Epigynum. *Hololena altura* Chamberlin and Ivie, n. sp. 52. Left palpus, ventral view. 53. Epigynum.



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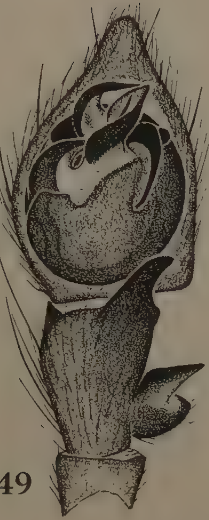

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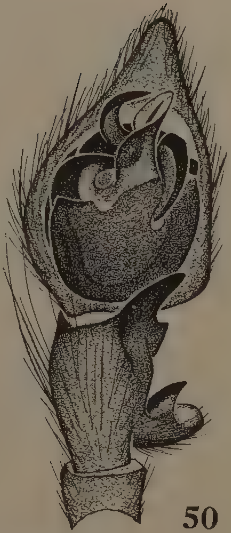

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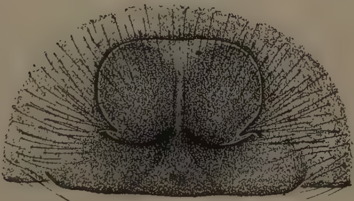

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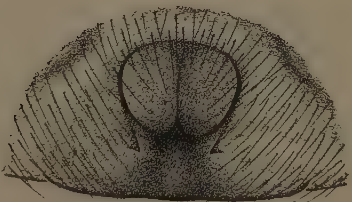

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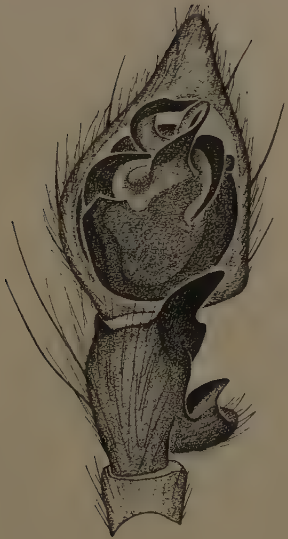

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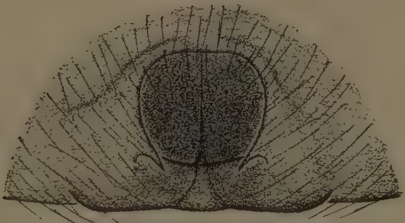

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lassena, but the tip of the distal process of the conductor is of a different shape.

Measurements:	♂ Holotype	♀ Allotype
Length	8.00 mm.	9.00 mm.
Carapace:		
Length	4.00	4.50
Width	2.75	2.90
Tibia-patella:		
I	4.40	4.10
IV	5.00	4.65

Type locality: W 122° 25′ : N 41° 25′, Weed, California; ♂ holotype, ♀ allotype ♂s and ♀s paratypes; September 8, 1935. Chamberlin and Ivie collectors. (U. U., A. M.)

Genus **Novalena** Chamberlin and Ivie, new

Agelena (in part), various authors.
Agelenopsis (in part), F. Cambridge, 1902, Biologia Centrali-Americana, 2: 336–338.
Agelena (subgenus *Hololena*) (in part), Exline, 1938, Univ. Wash. Publ. Biol., 9: 28.
Novalena Chamberlin and Ivie, 1941, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Typical color: Carapace with the usual color pattern (i. e., as in *Hololena*), except that the brown bands are usually more diffused or broken, and the whole carapace is more shaded. Chelicerae reddish brown, more or less shaded with dusky. Sternum yellowish brown, shaded with dusky; more shaded on lateral margins, less along mid-line. Labium and endites brownish orange, with whitish tips; the labium slightly shaded with dusky. Legs yellowish brown, shaded with dusky; the femur with a conspicuous pale annulus at base; faint annuli sometimes discernible on tibia. Abdomen dark gray, with a typical pattern above, much as in *Hololena*, but shaded with gray; venter dark gray, with a whitish line along each side. Spinnerets orange brown.

Typical structure: In general close to *Hololena*. Anterior eyes larger than the posterior eyes; the four eyes of each row, usually about equal. Chelicerae with two or three teeth on posterior margin of fang groove. Hind spinnerets with the apical segment about the same length as the basal segment. Spines on legs essentially as in the typical Ageleneae.

Epigynum ordinarily much reduced, with considerable variation in details of structure among the different species.

Palpus: Femur and patella unmodified. Tibia short, and variously sculptured on the ectal side. The cymbium is simple, with the distal prolongation short. The tegulum is simple and extends directly into the embolus, which is short and simple. The median apophysis is not significantly different from that of *Hololena* or *Calilena*, but shows considerable variation between species. The fulcrum is poorly or not at all developed, as in *Calilena*, and as in distinct contrast to *Hololena*. The conductor has a short distal process, which contains the tip of the embolus, and a short flat tail-piece dorsal or ectal to the distal process.

Genotype: *Novalena intermedia* (Chamberlin and Gertsch) (from Agelena).

This genus consists of a number of quite different forms, so far as the structure of the palpus and epigynum is concerned.

It seems to be one of the more common forms in Mexico and Central America, and extends northward in the western United States to Canada. This genus shows close relationship to the genera *Calilena*, *Hololena*, and *Rualena*. From *Hololena*, it is distinguishable by its darker color, longer hind spinnerets, the reduced epigynum in the female, and in the male by the fact that the tip of the embolus is held by the distal process of the conductor and not by a well-developed fulcrum. From *Calilena*, it can be distinguished by the shorter hind spinnerets, and in the female by the absence of the median stylus on the epigynum. From *Rualena*, it differs in its larger size, darker color and less delicately constructed palpus and epigynum. (We were somewhat hesitant about separating *Novalena* and *Rualena*, but finally did so on the basis of the differences mentioned above. We must admit, however, that intuition played a considerable part in this decision.)

Novalena intermedia (Chamberlin and Gertsch)

(Figs. 54–55)

Agelena intermedia Chamberlin and Gertsch, 1930, Proc. Biol. Soc. Wash., 43: 143, fig. 28.
Agelena (Hololena) intermedia Exline, 1938, Univ. Wash. Publ. Biol., 9: 28.
Novalena intermedia Chamberlin and Ivie, 1941, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Color typical. Structure essentially typical. Hind margin of the fang groove of the chelicerae with a small third tooth between the usual two, in the female, but not in the male. The structure of the palpus and epigynum is shown in the figures.

Measurements:	♂ Holotype	♀ Allotype
Length	9.00 mm.	9.00 mm.
Carapace:		
Length	4.60	4.40
Width	3.00	3.00
Tibia-patella:		
I	4.65	4.25
IV	5.40	4.70

Type locality: W 122° 17′ : N 37° 20′, La Honda, California; ♂ holotype, ♀ allotype; November 4, 1922; J. C. Chamberlin collector. (U. U.)

Known Localities:

120.39 ♂—Nevada County, California. (A. M.)
121.40 ♂—Mt. Lassen Park, California; June 28, 1940; W. M. Pearce. (A. M.)
122.47 ♀—Seattle, Washington. (A. M.)
122.42 —Crater Lake, Oregon. (Exline).
" " 2♂ 4♀—Base of Mt. McLaughlin, Oregon; June 22, 1934; Lawrence. (A. M., U. U.)
" " ♀—Lake of Woods, Oregon; July 1-4, 1934; Lawrence. (A. M.)
122.37 ♂ ♀—(Type locality.)
123.47 —No. Fork Skokomish River, Washington. (Exline).

Novalena pina Chamberlin and Ivie, new species

(Fig. 56)

Novalena intermedia, Chamberlin and Ivie, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Color similar to that of *intermedia.* The structure is also similar, except for a slight difference in the epigynum, as shown in the figures.

Measurements:	♀ Holotype
Length	10.50 mm.
Carapace:	
Length	4.30
Width	3.00
Tibia-patella:	
I	3.80
IV	4.40

Type locality: W 120° 52′ : N 38° 8′, Echo Lake, California; ♀ holotype, ♀ paratype; July 1934; L. W. Saylor. (U. U.)

Novalena approximata (Gertsch and Ivie)

(Fig. 63)

Agelena approximata Gertsch and Ivie, 1936, Amer. Mus. Novitates, No. 858: 23, ff. 45, 51, 52.

Color and structure essentially typical.

Measurements:	♂ Holotype	♀ Allotype
Length	7.10 mm.	10.50 mm.
Carapace:		
Length	3.80	5.00
Width	2.40	3.20
Tibia-patella:		
I	3.40	3.80
IV	3.90	4.40

Type locality: W 84° 5′ : N 9° 59′; San Jose, Costa Rica; ♂ holotype, ♀ allotype. (A. M.)

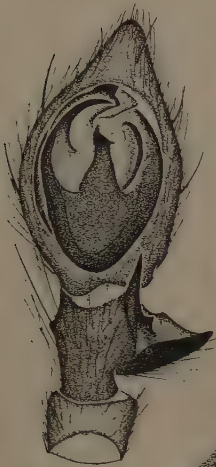
Novalena tolucana (Gertsch and Davis)

Agelena tolucana Gertsch and Davis, 1940, Amer. Mus. Novitates, No. 1059: 3, ff. 4, 6.

Color and general structure typical. A. M. eyes smaller than the A. S. eyes. The palpus is very similar to that of *approximata*; the epigynum is much different.

EXPLANATION OF PLATE VII

Novalena intermedia (Chamberlin and Gertsch). 54. Left palpus, ventral view. 55. Epigynum. *Novalena pina* Chamberlin and Ivie, n. sp. 56. Epigynum. *Novalena idahoana* (Gertsch). 57. Epigynum. *Novalena wawona* Chamberlin and Ivie, n. sp. 58. Epigynum. *Novalena lutzi* (Gertsch). 59. Left palpus, ventral view. 60. Epigynum. *Novalena calavera* Chamberlin and Ivie, n. sp. 61. Left palpus, ventral view. 62. Epigynum. *Novalena approximata* (Gertsch and Ivie). 63. Left palpus, ventral view.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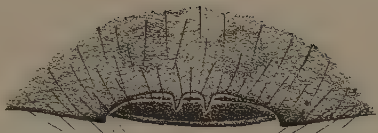
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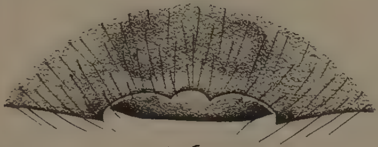
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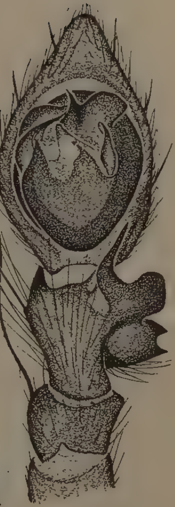
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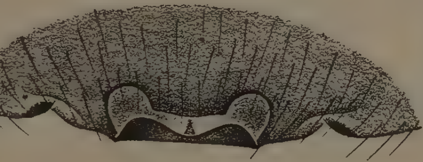
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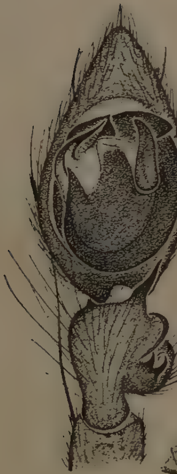
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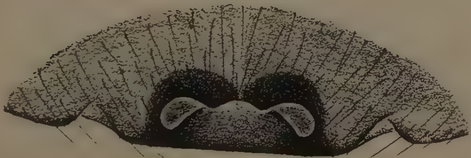
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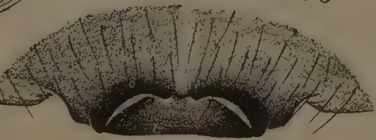
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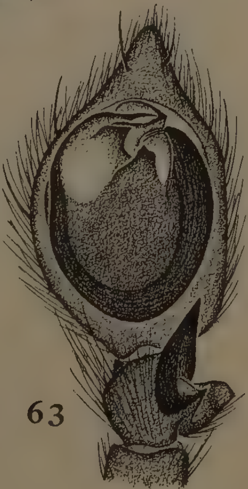
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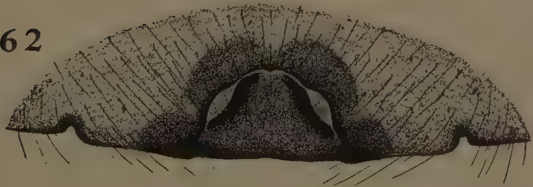
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Measurements:

	♂	♀
Length	9.10 mm.	9.60 mm.
Carapace:		
Length	4.70	4.50
Width	3.00	3.00
Tibia-patella:		
I	3.10	3.75
IV	4.60	4.35

Type locality: W 99° 42′ : N 19° 10′, Mt. Toluca, Mexico; ♀ holotype, ♂ allotype, ♀ paratype; June 28, 1936; A. M. and L. I. Davis. (A. M.)

Known Localities:

98.19 ♀—Mt. pass east of Mexico City, Mexico; June 20, 1936; A. M. and L. I. Davis. (A. M.)
99.19 ♂ 2♀—(Type locality.)
" " ♂—Mexico City, Mexico; April, 1941; H. Wagner. (A. M.)

Novalena attenuata (F. Cambridge)

Agelenopsis attenuata F. Cambridge, 1902, Biol. Centr. Amer., 2: 337, Pl. 32, f. 7.
Agelena attenuata Petrunkevitch, 1911, Catalogue, p. 527.

Length of female 7.5 mm. No other description given. The figure of the epigynum is evidently of the *Novalena* type.

Type locality: Omilteme, Guerrero, Mexico; ♀ holotype; H. H. Smith collector. (Godman and Salvin collection).

Novalena costata (F. Cambridge)

Agelenopsis costata F. Cambridge, 1902, Biol. Centr. Amer., 2: 337, Pl. 32, f. 6.
Agelena costata Petrunkevitch, 1911, Catalogue, p. 527.

Total length of female 13 mm. Carapace brown with an indistinct, broad, central and marginal band. Abdomen brown, with a broad, central, dentated, dull red band. Legs dark red-brown, femora distinctly annulated with black. (F. Cambridge.)

Type locality: About W 84° : N 10°, Costa Rica; ♀ holotype; Rodgers collector. (Godman and Salvin collection.)

Novalena nova (Cambridge)

Agelena nova Cambridge, 1896, Biol. Centr. Amer., 1: 175, Pl. 22, f. 5.
Agelenopsis nova F. Cambridge, 1902, Ibid., 2: 336, Pl. 31, f. 35.
Agelena nova Petrunkevitch, 1911, Catalogue, p. 528.

Total length 6 mm.

Type locality: Vera Paz, Guatemala; ♂ holotype; Sarg collector. (Godman and Salvin collection.)

Novalena marginata (F. Cambridge)

Agelenopsis marginata F. Cambridge, 1902, Biol. Centr. Amer., 2: 336, Pl. 31, f. 36.
Agelena marginata Petrunkevitch, 1911, Catalogue, p. 528.

Total length of female 9 mm. Carapace brown, with a broad central and marginal white longitudinal band. Abdomen brown, with a broad, pale, central, longitudinal band, the anterior third brown, the posterior portion dull red. Legs yellow brown, femora distinctly annulate. (F. Cambridge.)

Type locality: Omiltème, Guerrero, Mexico; ♂ holotype; H. H. Smith collector. (Godman and Salvin collection.)

Novalena annamae (Gertsch and Davis)

Agelena annamae Gertsch and Davis, 1940, Amer. Mus. Novitates, No. 1059: 2, ff. 3, 7, 8.

Color essentially typical. A. M. eyes smaller than the A. S. eyes. Hind margin of fang groove with three small teeth. Anterior margin of the epigynum with two cusps.

Measurements:	♂	♀
Length	7.50 mm.	9.50 mm.
Carapace:		
Length	3.80	4.45
Width	2.40	2.80
Tibia-patella:		
I	4.05	4.30
IV	4.72	4.95

Type locality: W 100° 28′ : N 19° 21′, Zitacuaro, Michoacan, Mexico; ♀ holotype, ♂ allotype; June 27, 1936; L. I. Davis. (A. M.)

Novalena idahoana (Gertsch)

(Fig. 57)

Color and structure typical. Anterior eyes equal. Hind margin of fang groove on the chelicerae with two teeth. Epigynum as figured.

Measurements:	♀
Length	10.00 mm.
Carapace:	
Length	4.80
Width	3.20
Tibia-patella:	
I	4.60
IV	5.30

Type locality: W 111° 18′ : N 42° 18′, Montpelier, Idaho; ♀ holotype; August, 1931; W. J. Gertsch collector. (A. M.)

Known Localities:

110.39	♀—Price, Utah; September, 1940; Harold Higgins. (U. U.)
111.42	♀—(Type locality.)
111.40	♀s—Wasatch Mts., Utah; various localities and dates. (U. U.)

Novalena lutzi (Gertsch)

(Figs. 59–60)

Agelena lutzi Gertsch, 1933, Amer. Mus. Novitates, No. 637: 12, f. 9.

Close to *idahoana*. Color and structure in general typical. The light parts of the cephalothorax are conspicuously clothed with pale gray hairs.

Measurements:	♂	♀
Length	7.70 mm.	10.50 mm.
Carapace:		
Length	3.90	5.20
Width	2.95	3.50
Tibia-patella:		
I	4.85	4.80
IV	5.60	5.60

Type locality: W 108° : N 37°, Mesa Verde Park, Colorado; ♂ holotype; July, 3–7, 1919; F. E. Lutz collector. (A. M.)

Known Localities:

105.39 ♀—15 mi. West of Denver, Colorado; August 24, 1935; W. Ivie. (U. U.)
107.32 ♀—Nimbres Mts., New Mexico; September 7, 1941; Wilton Ivie. (U. U.)
108.37 ♂—(Type locality.)
110.38 2♀—Horse Valley, Henry Mts., Utah; April 7, 1929; W. J. Gertsch. (U. U.)
112.37 ♀—Cedar Canyon, Utah; June 10, 1927; R. V. Chamberlin. (U. U.)
112.36 4♂—Kaibab Forest, Arizona; June 14, 1934; Ivie and Rasmussen. (U. U.)

Novalena wawona Chamberlin and Ivie, new species

(Fig. 58)

This species is close to *idahoana* and *lutzi*. The color is similar. The front eyes are large and equal, as in those species. The chelicerae have only two teeth on the hind margin of the fang-groove.

Measurements:	♀ Holotype
Length	11.00 mm.
Carapace:	
Length	5.40
Width	3.70
Tibia-patella:	
I	5.20
IV	6.00

Type locality: W 119° : N 37°, Wawona Camp, Yosemite Park, California; ♀ holotype; September 17, 1941; Wilton Ivie collector. (U. U.)

Novalena calavera Chamberlin and Ivie, new species

(Figs. 61–62)

This large species is closely related to the three foregoing species. The palpus has a pair of sharp points on the basal part of the tibia, as in lutzi, but differently shaped. The eyes and armature of the chelicerae are similar.

Measurements:	♂ Holotype	♀
Length	9.35 mm.	11.40 mm.
Carapace:		
Length	4.85	5.90
Width	3.33	4.00
Tibia-patella:		
I	5.72	5.70
IV	6.50	6.50

Type locality: W 120° 21′ : N 38° 49′, Riverton, California; ♂ holotype, ♀ allotype; 3 ♀ paratypes; July 15, 1934; Ivie and Rasmussen collectors. (U. U., one ♀ A. M.)

Novalena orizaba (Banks)

Agelena orizaba Banks, 1898, Proc. Calif. Acad. Sci., 1: 231, Pl. 14, f. 30.
Agelenopsis orizaba F. Cambridge, 1902, Biol. Centr. Amer., 2: 338.
Agelena orizaba Petrunkevitch, 1911, Catalogue, p. 528.

The following is a copy of the original description:

"Length ♀ 9 mm. Cephalothorax and legs rather reddish yellow, faint traces of marks on the former; abdomen grayish, rather uniformly finely netted with brown and a pale stripe above, dentate behind and margined with blackish spots; spinnerets pale; venter brownish; sternum yellow-brown; mandibles red-brown. P. M. E. less than diameter apart, as far from the P. S. E. Last joint of the superior spinnerets shorter than the basal one. The epigynum has a transverse bridge somewhat like that of *A. naevia*, at end of which there is a black mark."

Type locality: W 97° : N 19°, Mt. Orizaba, Mexico; ♀ holotype. (Presumably destroyed in San Francisco earthquake and fire in 1906.)

We are not certain of the position of this species from the description and figure, but it appears most probable that it belongs in this genus.

Novalena lobata (F. Cambridge)

Agelenopsis lobata F. Cambridge, 1902, Biol. Centr. Amer., 2: 336, Pl. 32, f. 2.
Agelena lobata, Petrunkevitch, 1911, Catalogue, p. 528.

Female. Total length 8 mm. Carapace brown, with a broad central and marginal pale band. Sternum brown, with a narrow central, pale band. Abdomen deep brown, with an indistinct, pale, dull, red, central band. Legs yellow-brown, femora distinctly annulated with black, (F. Cambridge).

Type locality: Omilteme, Guerrero, Mexico; ♀ holotype; H. H. Smith collector. (Godman and Salvin collection).

Novalena cuspidata (F. Cambridge)

Agelenopsis cuspidata F. Cambridge, 1902, Biol. Centr. Amer., 2: 337, Pl. 32, f. 3.
Agelena cuspidata Petrunkevitch, 1911, Catalogue, p. 527.

Female. Total length 8 mm. Color same as in *N. lobata*. (F. Cambridge.)

Type locality: Omilteme, Guerrero, Mexico; H. H. Smith collector. (Godman and Salvin collection).

Novalena variabilis (F. Cambridge)

Agelenopsis variabilis F. Cambridge, 1902, Biol. Centr. Amer., 2: 338, Pl. 32, f. 9.
Agelena variabilis Petrunkevitch, 1911, Catalogue, p. 529.

Female. Total length 12 mm. Carapace brown, with a broad central and marginal band of white hairs. Abdomen with a broad, central, red band margined with yellow-white; ventral area pale dun-color. Legs deeply and almost entirely suffused with brown, the femora with a long pale slash on the outer side. The epigynum appears to be exceedingly variable. (F. Cambridge.)

Type locality: Omilteme, Guerrero, Mexico; Duges collector.

Other Localities:

99.17 ♀—Chilpancingo, Mexico.
♀—Xautipa, Mexico. (Godman and Salvin collection.)

Genus **Rualena** Chamberlin and Ivie, new

Color very similar to that of a typical *Hololena*. Carapace with a wide, median, light band, as wide or wider than the eye area in front, slightly narrowed on thoracic part; the usual pair of brownish bands, and a wide light band on margin of thorax. Chelicerae reddish brown. Labium and endites orange, with whitish tips; the labium lightly shaded with gray. Sternum yellowish, with a narrow light median line extending the full length; the rest shaded or mottled with gray. Legs light yellowish brown, with faint annuli sometimes present. Abdomen with a broad, pale, dentate band above, sometimes enclosing on the basal part a lanceolate mark of darker gray; upper sides, next to mid-band, dark gray, lighter below and more or less spotted. Venter pale gray or yellowish-gray, with a broken black line along each side, more or less specked with dark gray.

Structure: Anterior median eyes distinctly smaller than the lateral eyes; posterior eyes equal, equidistant, about three-fourths diameter apart. Chelicerae with two teeth on hind margin of fang groove. Spines of legs essentially the same as in *Hololena*. Hind spinnerets with the apical segment the same length or slightly shorter than the basal segment.

Epigynum: A small cavity, sometimes partially divided, with a lateral ridge, which usually ends posteriorly in one or two points; usually a ridge across the posterior end of the cavity.

Palpus very simple. The tibia usually has a distal process on the ectal side, which is developed into two points; or this process may be absent. The palpal organs are of the same general pattern as those of *Novalena*. The whole structure is more delicate than in *Novalena*.

Genotype: Rualena surana Chamberlin and Ivie, n. sp.

This genus is very close to *Novalena* (see remarks under *Novalena*). The whole general appearance, however, is different; it being lighter in color, usually smaller in size, with a distinct difference in the general appearance of the palpus and epigynum. The study of more species may possibly justify its being relegated to the rank of a sub-genus.

Rualena simplex (F. Cambridge)

Agelenopsis simplex F. Cambridge, 1902, Biol. Centr. Amer., 2: 336, Pl. 32, f. 1.
Agelena simplex Petrunkevitch, 1911, Catalogue, p. 528.

Male. Total length 9 mm. Carapace brown, with a central and marginal pale band. Abdomen deep brown, with an indistinct, dentated, pale, central band. Legs brown, femora distinctly annulated with darker brown. Palpus simple, without external processes on the tibia. (F. Cambridge.)

Type locality: Guatemala; ♂ holotype; Sarg collector. (Godman and Salvin collection.)

Rualena cavata (F. Cambridge)

Agelenopsis cavata F. Cambridge, 1902, Biol. Centr. Amer., 2: 337, Pl. 32, f. 5.
Agelena cavata Petrunkevitch, 1911, Catalogue, p. 527.

Female. Total length 7.5 mm. This species is evidently closely related to *cruzana*, which follows, and probably agrees with it rather closely in color and structure. The epigynum is of the same sort.

Type locality: Omilteme, Guerrero, Mexico; ♀ holotype; H. H. Smith collector. (Godman and Salvin collection.)

Rualena cruzana Chamberlin and Ivie, new species

(Figs. 65–66)

Color and structure typical, the significant differences being in the palpus and epigynum, which are illustrated.

Measurements:	♂ Holotype	♀
Length	5.30 mm.	9.50 mm.
Carapace:		
Length	2.80	4.70
Width	1.95	3.30
Tibia-patella:		
I	3.15	4.40
IV	3.70	5.15

Type locality: W 119° : N 34°, Santa Cruz Island, California; ♂ holotype, ♀ allotype, several ♀ paratypes; March, 1913; R. V. Chamberlin collector. (U. U., ♀ A. M.)

Rualena rua (Chamberlin)

Agelena rua Chamberlin, 1920, Journ. Ent. and Zool., 12: 9, Pl. 4, f. 1.

The color is essentially typical. In structure, it is closely related to *cruzana*.

Measurements:	♂
Length	7.00 mm.
Carapace:	
Length	3.20
Tibia-patella:	
I	4.50
IV	4.70

Type locality: W 118° 20′ : N 33° 21′, Avalon Bay, Santa Catalina Island, California; ♂ holotype; August 25, 1918; Wm. A. Hilton collector. (M. C. Z.)

Rualena cockerelli Chamberlin and Ivie, new species

(Fig. 67)

Color of the typical pattern, somewhat darker than usual, with fairly distinct annuli on the femora of the legs. The epigynum is figured.

Measurements:	♀ Holotype
Length	9.30 mm.
Carapace:	
Length	4.15
Width	2.67
Tibia-patella:	
I	3.80
IV	4.40

Type locality: About W 120° 25′ : N 34° 3′, San Miguel Island, California; ♀ holotype, ♀ paratype; summer 1938; T. D. A. Cockerell collector. (A. M.)

Rualena surana Chamberlin and Ivie, new species

(Fig. 68)

Rualena surana Chamberlin and Ivie, 1941, Bull. Univ. Utah, 31(8):9 [Biol. ser. 6(3):9].

Color and structure typical. Color light brownish yellow in general, as is typical for light colored specimens of *Hololena.*

Measurements:	♀ Holotype
Length	7.20 mm.
Carapace:	
Length	3.40
Width	2.30
Tibia-patella:	
I	3.00
IV	3.40

Type locality: W 121° 52′ : N 36° 16′, Big Sur, California; ♀ holotype, ♀ paratype; April 10, 1937; L. W. Saylor collector. (U. U.)

Rualena goleta Chamberlin and Ivie, new species

(Figs. 69–70)

A light colored species of typical color pattern, and typical structure. The annuli on the legs are very faint. Minor differences in the palpus and epigynum distinguish it from other closely related species.

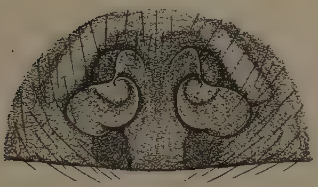
Measurements:	♂ Holotype	♀
Length	7.20 mm.	8.50 mm.
Carapace:		
Length	3.50	4.20
Width	2.45	2.85
Tibia-patella:		
I	4.30	3.90
IV	4.60	4.50

Type locality: W 119° 50′ : N 34° 28′, near Goleta, California; ♂ holotype, ♀ allotype, ♀ paratypes; July 12, 1934; W. Ivie and H. Rasmussen collectors; several ♀ paratypes, Sept. 16, 1941, W. Ivie collector. (U. U.)

EXPLANATION OF PLATE VIII

Melpomene coahuilana (Gertsch and Davis). 64. Epigynum. *Rualena cruzana* Chamberlin and Ivie, n. sp. 65. Left palpus, ventral view. 66. Epigynum. *Rualena cockerelli* Chamberlin and Ivie, n. sp. 67. Epigynum. *Rualena surana* Chamberlin and Ivie, n. sp. 68. Epigynum. *Rualena goleta* Chamberlin and Ivie, n. sp. 69. Left palpus, ventral view. 70. Epigynum. *Rualena avila* Chamberlin and Ivie, n. sp. 71. Epigynum. *Rualena alleni* Chamberlin and Ivie, n. sp. 72. Epigynum. *Rualena magnacava* Chamberlin and Ivie, n. sp. 73. Epigynum.

PLATE VIII



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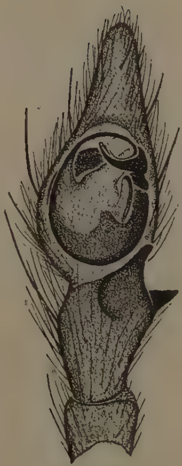

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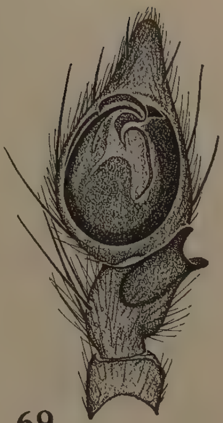

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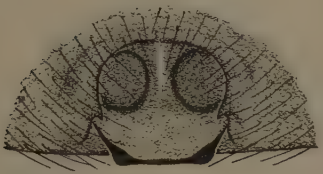

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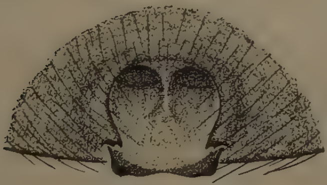

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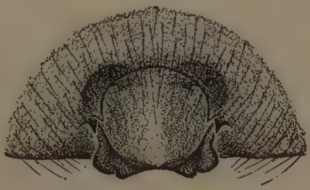

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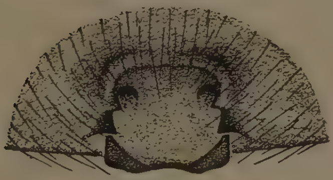

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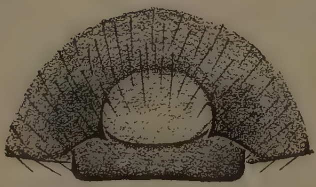

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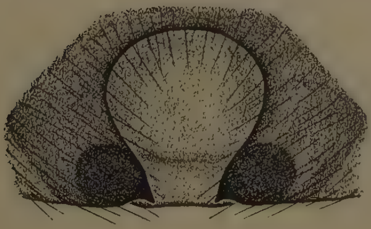

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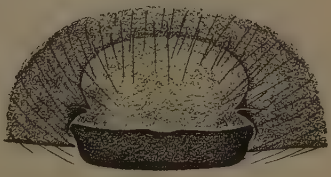


72

Rualena avila Chamberlin and Ivie, new species

(Fig. 71)

Color typical. Epigynum with a heavy posterior ridge. Hind spinnerets short, with apical segment slightly shorter than basal.

Measurements:	♀ Holotype
Length	7.00 mm.
Carapace:	
Length	2.80
Width	2.00
Tibia-patella:	
I	2.65
IV	3.00

Type loaclity: About W 120° 40′ : N 35° 16′, San Luis Obispo, California; ♀ holotype; August 3, 1931; R. V. Chamberlin collector. (U. U.)

Rualena alleni Chamberlin and Ivie, new species

(Fig. 72)

Color typical; annuli fairly distinct on under sides of femora. Structure similar to that of *avila*, except for differences in the epigynum.

Measurements:	♀ Holotype
Length	9.50 mm.
Carapace:	
Length	4.40
Width	3.00
Tibia-patella:	
I	4.20
IV	5.00

Type locality: About W 119° 30′ : N 33° 15′, San Nicholas Island, California; ♀ holotype, ♀ paratype; July, 1938; Harry Allen collector. (A. M.)

Rualena magnacava Chamberlin and Ivie, new species

(Fig. 73)

Color essentially typical. Legs with distinct annuli on femora and tibiae. Abdomen with a median dusky lanceolate mark on basal part above. Epigynum with a large horse-shoe shaped depression. Hind spinnerets with the apical segment very slender and fully as long as the basal segment.

Measurements:	♀ Holotype
Length	7.00 mm.
Carapace:	
Length	2.95
Width	1.85
Tibia-patella:	
I	2.95
IV	3.65

Type locality: W 116° 8′ : N 32° 20′, Mountain Springs, California; ♀ holotype, ♀ paratype; January 8, 1941; Dorothea and Stanley Mulaik collectors. (U. U.)

Genus **Melpomene** Cambridge

Melpomene Cambridge, 1898, Biol. Centr. Amer., 1: 285.
Agelenopsis (in part), F. Cambridge, 1902, Ibid., 2: 336.
Agelena (in part), Petrunkevitch, 1911, Catalogue, p. 527.

Color variable; the following will be taken as typical, with variations from it noted under each species:

Carapace with a black marginal seam along each side of the thorax, above which is a wide whitish band, which may extend as far forward as the clypeus; a narrow median light band extending the full length above; the rest dusky brown, with blackish reticulations on the side of the head, and radial marks on the thorax. Chelicerae reddish brown. Labium and endites orange brown, with whitish tips; the labium shaded with dusky. Sternum orange, variously marked or shaded with dusky. Coxae of legs below orange, with the distal edge dusky. Legs brownish orange, more reddish distally; dark gray annuli usually present, but these are largely broken up into spots and blotches; a pale annulus distad of middle on femur, set off by dark gray, and a dusky annulus at base (the femur marked much as in *Novalena*). Abdomen dark gray above, lighter below; with a typical pattern above, consisting of a wide median band, containing a dark gray, broadly lanceolate mark on basal part, set off with pale broken lines, and a herring-bone pattern on distal half; lower sides mottled or spotted; ventral area dark gray, or light gray surrounded by dark gray. Spinnerets reddish brown, shaded with dusky.

Structure: Eyes all about equal; P. M. eyes about three-fourths of a diameter apart, only a radius from the side eyes. Chelicerae with four small teeth on the hind margin. Legs long and slender; tibia-patella I longer than carapace; spines small. Hind spinnerets with the terminal segment much longer than the basal segment, sometimes nearly twice as long.

Epigynum consists of a large cavity, divided by a broad median septum.

Palpus: Femur and patella unmodified. Tibia short, with the ectal side slightly sculptured, and with a short terminal process. Tarsus moderately large; cymbium thin, deeply concave, with distal end more or less extended. The palpal organs show considerable variation in detail. The tegulum is more or less extended into one or more chitinized processes. Embolus variously coiled or twisted, with the tip held by a well-developed fulcrum. Median apophysis small or absent. Conductor situated distally, well-developed.

Genotype: Melpomene elegans Cambridge.

This genus is readily distinguished from most others by the four teeth on the hind margin of the fang groove and the long terminal segment of the hind spinnerets. This genus is most nearly related to *Agelenopsis* and *Tortolena*.

Melpomene elegans Cambridge

Melpomene elegans Cambridge, 1898, Biol. Centr. Amer., 1: 285, Pl. 39, f. 6.
Agelenopsis elegans F Cambridge, 1902, Ibid., 2: 336, Pl. 31, f. 37.
Agelena elegans Petrunkevitch, 1911, Catalogue, p. 527.

Male. Length 11.25 mm. Color and structure evidently typical. The sternum has the central portion dark brown, with a pale yellow-brown spot in the middle, and the broad margins pale yellow-brown.

Type locality: W 99° 12′ : N 18° 55′, Cuernavaca, Morelos, Mexico; ♂ holotype; H. H. Smith collector. (Godman and Salvin collection.)

Melpomene bicavata (F. Cambridge)

(Figs. 74–76)

Agelenopsis bicavata F. Cambridge, 1902, Biol. Centr. Amer., 2: 337, Pl. 32, f. 4.
Agelena bicavata Petrunkevitch, 1911, Catalogue, p. 527.

Color: Carapace with a distinct narrow, light, median line, extending from the median ocular area to the base. Sternum dusky brown, with a yellowish median mark on the anterior half, and faintly darker radial marks. Venter of abdomen dark gray; lower sides spotted. Color otherwise essentially typical.

Structure in general typical, with a distinctive palpus and epigynum, as shown by the figures.

Measurements:	♂	♀
Length	7.70 mm.	9.10 mm.
Carapace:		
Length	3.50	3.75
Width	2.60	2.70
Tibia-patella:		
I	4.70	4.20
IV	5.00	4.65

Type locality: Omilteme, Guerrero, Mexico; ♀ holotype; H. H. Smith collector. (Godman and Salvin collection.)

Known Localities:

84.9 ♂ ♀—San Jose, Costa Rica. (A. M.)
♀ —(Type locality.)

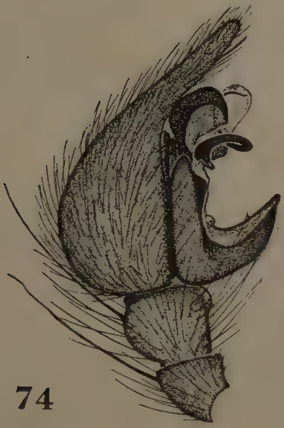
Melpomene plesia Chamberlin and Ivie, new species

(Fig. 77)

Color: Reticulations and radial marks of carapace distinct; median band indistinct; top of head back of eyes pale, with a dark mark on each side behind. Sternum broadly orange medially, gradually becoming dusky on lateral margins. Legs typical. Dorsum of abdomen typical;

EXPLANATION OF PLATE IX

Melpomene bicavata (F. Cambridge). 74. Left palpus, mesal view. 75. Left palpus, ventral view. 76. Epigynum. *Melpomene plesia* Chamberlin and Ivie, n. sp. 77. Epigynum. *Melpomene chiricana* Chamberlin and Ivie, n. sp. 78. Epigynum. *Melpomene singula* (Gertsch and Ivie). 79. Left palpus, ventral view. 80. Left palpus, ectal view.



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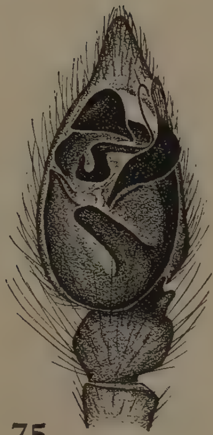

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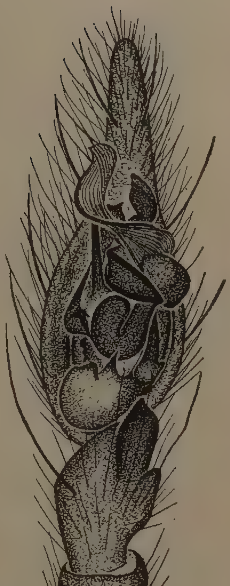

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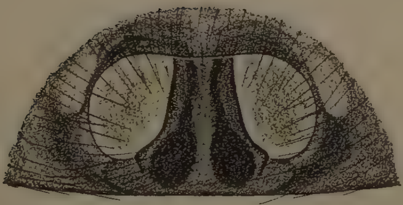

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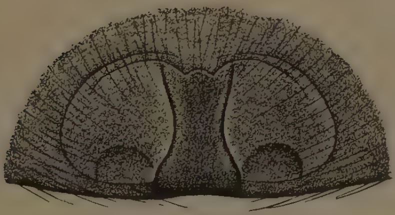

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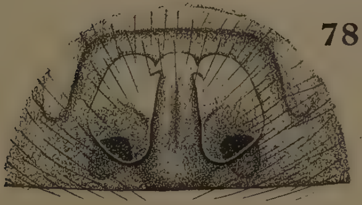

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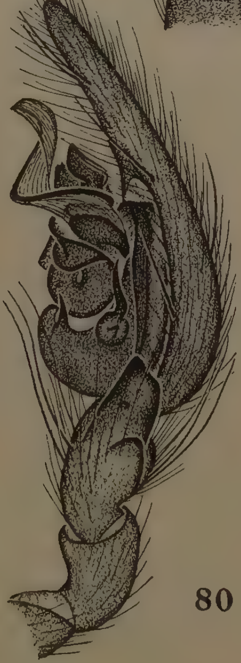

80

sides mottled, rather than spotted; venter pale in center, surrounded by dary gray.

Structure essentially typical; epigynum as figured.

Measurements:	♀ Holotype
Length	8.20 mm.
Carapace:	
Length	3.50
Width	2.55
Tibia-patella:	
I	4.35
IV	4.70

Type locality: El Volcan, Chiriqui Province, Panama; ♀ holotype, 2 ♀ paratypes; February 23, 1936; W. J. Gertsch collector. (A. M., ♀ U. U.)

Melpomene chiricana Chamberlin and Ivie, new species

(Fig. 78)

Color similar to that of *plesia*. Structure essentially typical. A. M. eyes slightly smaller than the others. Terminal segment of the hind spinnerets only a little longer than the basal segment.

Measurements:	♀ Holotype
Length	9.00 mm.
Carapace:	
Length	3.60
Width	2.60
Tibia-patella:	
I	4.10
IV	4.40

Type locality: Cerro Punta, Chiriqui, Panama: ♀ holotype; March 4, 1936; W. J. Gertsch collector. (A. M.)

Melpomene coahuilana (Gertsch and Davis)

(Fig. 64)

Agelena coahuilana Gertsch and Davis, 1941, Amer. Mus. Novitates, No. 1059: 2, f. 5.

Color essentially typical. Median band of carapace as wide as the eye area. Sternum dusky, somewhat paler in center. Legs strongly marked with dusky. Abdomen colored as in *plesia*.

The chelicerae has only three teeth on the hind margin of the fang groove. The epigynum is a distinctive type as shown by the figure.

Measurements:	♀ Holotype
Length	8.00 mm.
Carapace:	
Length	3.65
Width	2.30
Tibia-patella:	
I	3.65
IV	3.85

Type locality: W 100° 59′ : N 24° 40′, 5 mi. S. E. Saltillo, Mexico; ♀ holotype; November 26, 1937; A. M. and L. I. Davis collectors. (A. M.)

Known Localities:
100.24 ♀—(Type locality.)
101.22 ♀—W. San Luis Potosi, Mexico; June 7, 1941; A. M. and L. I. Davis. (A. M.)

Melpomene panamana (Petrunkevitch)

Agelena panamana Petrunkevitch, 1925, Trans. Conn. Acad. Sci., 27: 161, f. 82.

Color and structure evidently typical.

Measurements:	♀
Length	10.00 mm.
Carapace:	
Length	4.6
Width	3.1
Tibia-patella:	
I	5.2
IV	5.5

Type locality: Wilcox Camp, San Lorenzo River, Panama; ♀ holotype; Bocas del Monte ♀ paratype. (Collection of A. Petrunkevitch.)

Melpomene singula (Gertsch and Ivie)

(Figs. 79–80)

Agelena singula Gertsch and Ivie, 1936, Amer. Mus. Novitates, No. 858: 23, ff. 49–50.

Color and structure in general typical. Leg I longer than Leg IV. Palpus elongate, structure as shown in the figures.

Measurements:	♂ Holotype
Length	7.50 mm.
Carapace:	
Length	3.70
Width	2.55
Tibia-patella:	
I	6.30
IV	5.80

Type locality: W 96° 54′ : N 18° 52′, Cordova, Mexico; ♂ holotype. (A. M.)

Melpomene transversa (F. Cambridge)

Agelenopsis transversa F. Cambridge, 1902, Biol. Centr. Amer., 2: 336, Pl. 31, f. 38.
Agelena transversa Petrunkevitch, 1911, Catalogue, p. 529.

Male. Length 7 mm. Carapace brown, with a large, pale patch behind the eyes and a marginal band. Abdomen brown, with a pale central band, dentated in the posterior half. Legs dull yellow-brown, the femora very faintly annulated with darker brown. (F. Cambridge.)

Type locality: Omilteme, Guerrero, Mexico; ♂ holotype; H. H. Smith collector. (Godman and Salvin collection.)

BOOK NOTICES

THE NATURALISTS' DIRECTORY, 32ND EDITION, 1940, 292 pages plus advertising pages, paper bound. Published by THE CASSINO PRESS, Salem, Mass. Price, $3.00.

For the general collector this is one of the most useful books of which we know. With the death of its originator we had feared that it would be discontinued, but the demand was so urgent that with its established place in American natural history it has been kept going by Samuel Cassino's successors. It lists American naturalists by states and provinces (Canada) with those of other countries under their country's name. Each name is followed by the correct postal address and the person's interests. It gives a list of scientific periodicals and one of natural history museums. In its advertising pages it advertises foreign collectors and dealers. It lists about 6,000 naturalists, mostly American and Canadian.

The next edition (33rd) will appear in December, 1942.—C. H. K.

OUR SHADE TREES, by EPHRAIM PORTER FELT. Pages 1–320. 1941. 5½ x 8 inches. Published by the ORANGE JUDD PUBLISHING COMPANY, Inc., New York. Price, $2.00.

The purpose of this book is "to outline the relation of trees to suburban life, the needs of shade trees under prevailing conditions and to advise methods which will permit the owner to offset . . . the present day perils or hazards of shade trees."

In this revised and enlarged edition are incorporated the more important lessons of the 1938 hurricane, particularly those relating to growing trees to make them more resistant to storms. The discussion of windstorms has been largely rewritten and considerably amplified. The method of appraising storm damage to trees, which is amplified in this edition, seems a very satisfactory way of estimating tree losses and their effect on real estate values.

The table of contents is indicative of the scope of the book: I. Shade Trees and Men. II. General Shade Tree Care. III. The Language of Shade Trees. IV. The Troubles of Shade Trees. V. The Selection and Planting of Shade Trees. VI. Research and Education. VII. Control of Insects and Diseases. VIII. A List of Some of the More Useful Books on Trees and Shrubs.

This account of shade trees is clear, comprehensive, and up-to-date; it will be of interest to anyone interested in trees, and of considerable practical value to tree owners, tree wardens, city foresters, and others interested in the planting and management of shade trees. Its author, the Director of the Bartlett Tree Research Laboratories, has had over 40 years of experience with the problems of which he writes. The book is printed with large clear type on a good grade of paper, and contains 47 full-page half-tone plates.—D. J. BORROR.

BEETLES OF THE GENUS HYPERASPIS INHABITING THE UNITED STATES, by TH. DOBZHANSKY, Smithsonian Misc. Coll., Vol. 101, No. 6, 92 pages, 6 pls. Published by the SMITHSONIAN INSTITUTION with funds from the THOMAS LINCOLN CASEY FUND. Washington, D. C.

After his remarkable studies of the genetics of the species of Drosophila and particularly his studies of species wild and in the field, the author probably has a better concept of natural species than has the average collector or museum expert. Any monographic revision from his pen should reflect such experience. He had use of the material in about ten of the large collections of the United States.

In the plates he gives color patterns of our Two-spotted Lady Bird Beetle and its numerous relatives, also outlines of penes of the males. It is the type of illustrated monograph that helps students and collectors clear down to freshmen.

Dobzhansky is Russian by birth, a graduate of the University of Kief, a past lecturer in the University of Leningrad and from 1929 to about 1940 on the staff of the California Institute of Technology where he taught genetics. He is now on the staff of the Department of Zoology at Columbia University. His immediate reputation rests on his volume, "Genetics and the Origin of Species," published by the Columbia University Press in 1937. His basic interest and training in Russia was as an entomologist. We claim that he is still one of our very prominent entomologists.—C. H. K.

SUPPLEMENT TO INSECTS OF NORTH CAROLINA, by C. S. BRIMLEY, L. L. D. Pages 1–39. 1942. Paper bound. Published by the Division of Entomology, North Carolina Department of Agriculture.

On page 647, vol. 31 of these Annals for 1938, we gave a notice of "Insects of North Carolina," (price $2.00), Dr. C. S. Brimley of the North Carolina State Department of Agriculture. "The number of species in the different orders now stands as follows: Insects 10,401, Near-Insects or Forms Allied to Insects, 690; a grand total of 11,091 on December 31, 1941."

We have found this work and "The Insects of New York" very handy in editorial work where we use them to check the spelling of scientific names the Latin of which does not "sound quite right." They have also been used to the point of showing wear in checking distribution of species. While mere lists they are curiously useful works in times of real need. With Webster's Dictionary and "A Glossary of Entomology" by Torre-Bueno they stand within easy reach of our desk.—C. H. K.

PAPÉIS A VULSOS DO DEPARTAMENTO DE ZOOLOGIA, SECRETARIA DA AGRICULTURA, INDUSTRIA E COMERCIO, Estado Sao Paulo, Brasil. Vol. I, pp. i-vii and 1-273, illustrated. 1941.

We wish to call attention to this excellent biological journal recently established by the state of Sao Paulo, Brazil. It is of particular interest to entomologists because it carries many articles on the insect fauna of that area. Of the twenty-eight articles, eighteen are on new forms of insects, while four are on arachnids. The remaining articles are on mammals, 4, fish, 1, and worms, 1. The text and scientific descriptions are in Portuguese.

Few persons realize the extent of biological research in Brazil. Over seventy journals published in that area carry biological articles. The Editor of these Annals has made it a point to obtain material on the South American insect fauna in order to make the Annals useful to the many South American institutions who could subscribe to our journal. Our subscription list lost few items during the recent hard times. We are preparing for future difficulties.—C. H. K.

THE LIFE OF LANGSTROTH, AMERICA'S MASTER OF BEE CULTURE by FLORENCE NAILE, pages 1–215, 2 figs. and portrait. 1942. 5½ x 9 inches. Linen bound. Published by the CORNELL UNIVERSITY PRESS, Ithaca, N. Y. Price, $2.50.

Seldom have we enjoyed giving credit as much as we enjoy giving it now, not only to the author of the present volume but to Langstroth himself. Here was a man, a minister of the Gospel by education, who never called himself an entomologist but, who, through a study of the management of bees during the middle and latter part of a very long life, probably showed the way to more world profits than has any other student of insects. Langstroth was the inventor of the modern bee hive used now throughout the world wherever beekeeping has been put on a scientific basis. His studies have given civilization quantity honey production and indirectly have provided the means of the fertilization of the world's deciduous fruit. Without the quantity cultivation of the honeybee our great orchard and berry regions would produce only meagre crops.

Author Naile has an easy flowing style which completely submerges her composition in the running array of interesting facts concerning the activities of this unusual man. She has treated his life under the chapter headings:

I. Parentage and Boyhood. Langstroth was of English stock born in 1810 and reared in Philadelphia, his father a paper manufacturer. II. Student and Tutor at Yale. After graduation in 1831, educated for the ministry and elected to Phi

Beta Kappa, he taught and tutored for five years. III. Minister and Schoolmaster. In 1836 Langstroth was called to the South Church in Andover, Mass. While here he married Anne Tucker, the daughter of a mistress of a girls' school. Though successful in his chosen profession at the end of two years he resigned on account of an attack of poor health and taught in a local academy. In 1840 he moved to Greenfield, Mass., as principal of a girls' school where he also preached in the local church until 1848 when he again resigned because of poor health. IV. Observant Keeper of Bees. That same year he moved to Philadelphia. He had become interested in bees while at Andover and then and later in Philadelphia purchased several works on bees while also contacting any one interested in their rearing. He tried the various European forms of the bar hive which however did not solve the basic problem of combs glued to the top and sides of the hive. V. Discovery and Invention. In 1851 he discovered the use of a *bee space* of three-eighths of an inch above the bars which prevented the gluing of bars to the cover. That fall he devised the hanging spaced frame with a similar *bee space* between frames and between walls and frame ends. VI. Author and Journalist. In 1853 by financial aid of friends he published "Langstroth on the Hive and the Honey-Bee, a Bee Keepers Manual," 384 pages, which still is the classic of all classics in apiculture. VII. A New Era in Beekeeping. This is on his patent rights and the superior features of the movable frame hive. VIII. The Golden Bee Imported. The difficulties of, but final success in the importation of the tamer and more productive Italian bee. IX. Not to the Swift. Here are his difficulties in control of patent rights. X. A Chapter of Difficulties. We learn of his recurrent poor health of a nervous nature, his attempts to return to the ministry and a few words on his three remarkably helpful and generous brothers-in-law. XI. The Latter Years. His life at Oxford, Ohio, after the death of his wife, alternate periods of depression and poor health and of active work. XII. Estimate and Eulogy. A chapter on friends and admirers.

Three great accomplishments stand out in Langstroth's life. He invented the Langstroth hive based on a detailed study of bee habits, a hive in universal use in all enlightened areas today. He published "Langstroth on the Hive and the Honey-Bee" the first scientific work on apiculture, one that was translated into many languages. He made lasting and strong friendships all through life, ties with his relatives and with men of influence and ability who willingly saw him through his almost continuous financial difficulties brought on because of the recurrent periods of poor health.

Langstroth died on Sunday, October 6, 1895, in the pulpit of the Wayne Avenue United Presbyterian Church at Dayton, Ohio. He rests in Woodlawn Cemetery at Dayton under the inscription, "Father of American Beekeeping."

This volume is a must for all men who devote *their* lives to the painstaking study of insect life.—C. H. K.

BIRD PORTRAITS IN COLOR, Text by THOMAS SADLER ROBERTS. 90 plates in color of 295 North American Species. 8½ x 11¼ inches. Published by THE UNIVERSITY OF MINNESOTA PRESS, University of Minnesota, Minneapolis, Minn. Price, $3.50.

We quote from the Introduction: "Ever since the publication of 'The Birds of Minnesota,' some years ago, there has been a steady and growing demand for the plates illustrating that work, in a more convenient form. The larger work (two volumes) is too bulky and heavy to be carried afield or to meet all the requirements of the schoolroom and the casual bird lover. The text accompanying the plates is largely new and only here and there has matter from the earlier work been used directly."

The volume is a series of colored plates. On the back of each plate is text explanatory of the succeeding (facing) plate. This text is by Professor Roberts. The lovely plates are by various nationally known bird artists. One plate, No. 23, of flying quail, is by Louis Agassiz Fuertes. Thirty-six plates are by Allan Brooks among which those of the blue birds and robins, the thrushes and the kinglets show his work at its best. The twelve plates of sparrows and their relatives are by Walter Alois Weber. These are in a different, a harder type of drawing fitted best to such patterns as those of the bobolink and meadow lark.

A few plates are included which are drawn by Francis Lee Jacques and by Walter John Breckenridge. Perhaps the loveliest of all are those by George Miksch Sutton who figures the grouse, kingbirds, flycatchers and the vireos.

For those interested in the problems of bird illustration "Bird Portraits in Color" shows the specialized drawing used in this field and the differing techniques used by recent and present-day artists. In this branch of illustration shadows are minimized to avoid obscuring the details of color pattern. To obtain balance in design and to level out the brilliant and contrasting colors of the birds the artist has to resort to almost prismatic colors in the background. The clashes in color have to be offset by properly placed complimentary colors of slightly less intensity. A bird plate raises very intricate color-design problems. Only a few artists after long years of study and with a natural flair for associating colors ever really succeed in this field of illustration. If the student will compare Sutton's work with that of Audubon of a century earlier, one of the first to attack the problems, he will see the advances that have been made. Audubon came into the work from the school of human portraiture of his day where poses and facial expression were the essence of good art. Shadows were used for balance and design and bird colors had to be minimized to agree with such elements of composition. In those days of less expensive reproduction Audubon's birds were live things that strutted their stuff across a whole plate to one species. In our day of high art costs and concessions to the conveniences of condensation the birds have to be calm and in repose to get several species onto one plate. A hasty tempered bird in a modern plate would upset everything.

After feeding sunflower seeds to our backyard bedraggled redbirds and digging worms for John Q. and Mrs. Robin who are smudged from head to foot with win-the-war Columbus soot we wonder where the artists found the sprightly spick-and-span birds which are drawn in this book. We wonder how a bird lover can keep his mind even on birds when these disport themselves on azure lakes that shade into opalescent sky; and then the perfect sanitation where waterfowl congregate. Oh, for one dead fish and a bucket of mud! But this volume is a bird book set apart from the low keyed actualities of the environment. It is a jewel of lovely colors.

The text is without keys, descriptions or technicalities other than the insertion in Italics of the scientific name after each common name. In a running account it gives distribution of each species and a few sentences on habits or other matters of interest. "Bird Portraits in Color" is the greatest value we have seen in beauty and practical information for the very modest price of three and a half dollars. We are thrilled when we turn the pages in such a book. It becomes difficult to take our mind off the pictures long enough to set down our impressions.

—C. H. K.

COLLEGE ENTOMOLOGY, by E. O. Essig. Pages vii and 900, 308 figs. and map. 1942. Size 7½ x 6½ x 2 inches. Published by The Macmillan Company, 60 Fifth Avenue, New York. Price $5.00.

This excellent volume is one on the advanced taxonomy of insects, thirty-three chapters on orders and only three introductory or orienting chapters. The latter are: I. Metamorphosis of Insects; II. Anatomy of Insects; and III. Classification of Insects. Essig is distinctly visual minded, an artist and morphologist as is shown by the elegant illustrations of his technical papers and his national rating as a breeder of the lovely Iris. Throughout, the volume emphasizes morphology and gives physiology a second place. While such a presentation will not satisfy the physiologists and will limit the use of the book as a general text, it is as it should be. The volume is avowedly taxonomic, and, in spite of its broad title, taxonomy in its present development is based almost wholly on morphology. Few are well prepared mentally to write such a volume. We have always marvelled at Essig's ability and persistent drive.

While the title may have been a compromise with the publishers because of its sales value, an editor would have used one that was more precise. For several years we have been experiencing the need of such a review of insect taxonomy as our recent American texts have sadly lagged behind the knowledge of the advanced specialists. Because the preceding necessary steps in the evolution of taxonomic theory have already appeared and have been critically studied we have been ready for some years for a summation and expansion of their facts. Essig's work is the first American attempt to fill that gap with an adequately expanded and adequately illustrated text book.

The modern classification of insects was set up as a whole for the first time by Brauer, 1885. In 1898, 1899, Comstock and Needham published the system of wing vein nomenclature that bears their names and which for the first time was based directly on evolutionary data. This gave a great tool into the hands of taxonomists. In 1906–1908 Handlirsch applied the Comstock-Needham system of terms throughout his monumental work, "Die Fossilen Insekten," thus showing the Brauer and Comstock-Needham systems to be consistent with the fossil record. The Comstock texts carried the system as developed up to this point and used the Handlirsch ordinal terms as far as was compatible at that time with college text presentation. In Schröder, Handbuch der Entomologie, vol. III, 1928, Handlirsch again brought the system down to date. In 1915 Melander and Brues published "Keys to the Families of North American Insects" which followed the Handlirsch system and later, 1932, expanded this publication into a well illustrated volume of keys to cover the World fauna. In 1924 Imms gave us the first edition of his British Empire text which in that and later editions covered the World fauna but dropped back to a list of 23 orders. Thus had been built up our present system of taxonomy which is used by all specialists who have to do with the description and evolutionary arrangement of insect orders. Essig uses thirty-three orders which brings his volume down to date. Thus the material and times were ripe for the Essig book.

While physiology is given minor mention in the volume the author has brought together for the first time a great body of facts on habits and life histories. These paragraphs under each family caption make the volume interesting to the student and save it as a general text. We have enjoyed browsing through the volume and adding to our knowledge facts concerning many strange families, facts which frequently have become known only since the recent world wide education of experts in our science.

Our criticism of this otherwise excellent volume is that highly technical parts on orders with which the author had had little personal experience were not read in manuscript and criticized by carefully chosen experts. As everyone knows the literature on any order contains many and even pretentious publications of recent date that may be sadly out of date as to family placements, characterizations, keys, etc. The writer of a comprehensive text cannot always spot such. As an example the Comstock-Needham system as used for the Odonata has been shown by Tillyard, Martynov and Carpenter to be in error. Yet it is used in spots in this text.

The reviewer will have to admit here that he still uses it for its convenience to himself and other Odonatists who know the system and some of whom may not be familiar with the corrections recently introduced. But we are not publishing advanced texts. We do feel a twinge of shame every time we use this system. In this volume Essig uses the advanced system in fig. 82 for Lestes, but the earlier system in fig. 8 Aeschna (which should be Aeshna) and in fig. 85, Libellula with no caution to the reader that he switches from one to the other. In fig. 82 MA is "Media A" and not the medio-anal link as stated in the legend. The link is at the apex of the triangle. The key to Aeschnoidea, pp. 240, 241, uses the terms of the Tillyard system but the figure illustrating these terms is labelled under the Comstock-Needham system. As an Editor we are annoyed by page 246. This is four-fifths blank, which space could have carried references to the recent sound papers, mostly on paleontology, on the evolution and venation of Odonata. A writer covering a broad field needs expert friends; Essig has numerous such friends but has not used their expert advice.

The author has done one outstanding thing: he has had the courage to publish a much needed volume. From here on it will be only a problem of correcting details many of which any editor will acknowledge are not easily recognized until the matter is in print. The numerous illustrations are excellent. The matter is well chosen and arranged and written in an easy, flowing style. The styles of type are well chosen, lines spaced for easy reading and the paper and linen binding are of the best.—C. H. K.

INSECTS AND THEIR WAYS, by BERTHA MORRIS PARKER, illustrated by Elizabeth Newhall. Pages 1–36, 48 figures in color. Size 10½ x 8½ inches. 1942. Published by HARPER AND BROTHERS, 49 East 33rd Street, New York. Price $1.00.

Insects and their Ways is a child's introduction to the marvels of insect life. Its attractiveness lies in the many beautiful water colors which, drawn with few shadows, give an effect somewhat of the older shadowless Japanese block prints. In general it presents sound information of insect life histories and habits while the lovely pictures display the forms and colors. The book is excellent from an informative point of view in that each insect is presented in all its life forms, egg, larva, pupa and adult. In it an insect is always an insect as there is no anthropomorphic phraseology that suggests thought or intention on the part of individual insects. The life histories are of the cecropia moth, monarch butterfly, grasshopper, dragonfly, mosquito, mantis, bumblebee, back swimmer, ant lion, seventeen-year locust, aphid, ladybird and firefly. The final third of the volume outlines "Where insects live," Life histories, What insects eat, How insects protect themselves, Friends and enemies, and finally a few summary words, "Looking back." We like the book. It is a gorgeous effort to give the child a correct idea of the nature and habits of the more common insects.

Some curious very minor errors have crept into it, but nothing that should misinform a child seriously. The ant is chosen as illustrative of the division of the body into head, thorax and abdomen. Unfortunately in the higher Hymenoptera the fourth segment of the thorax is really the first segment of the abdomen. On page 6 the cecropia moth finds a little door in its cocoon through which it escapes. But this door is only in the outer shell. The moth dissolves the tough silk of the inner layer with KOH. On page 9 the grasshopper "shoots tobacco juice at you." We have never seen it actually shot. On pages 10 and 11 in the life history of the dragonfly the nymphs of the first three stages are libelluline and practically full grown. The last nymph and skin and adult are Aeshnine. On page 16 the drone (male) bumblebee has female antennae. But why point out such items? We could not do as well. We recommend the book highly as a very attractive and honest introduction of the child to the wonders of the insect world. The author, artist and publisher are to be commended for their really successful effort to get away from the fairy tale type of juvenile literature. A book can be very attractive and interesting as this is without a teleological or anthropomorphic phrase. Obviously such juvenile books as Insects and their Ways are indicative of the high standards strived for by the better authors and publishers.—C. H. K.

PRAIRIE DOG TOWN, by MARGARET T. RAYMOND AND CARL MOHR. 56 pages, 38 illustrations (14 full page). 1942. 6¾ x 9 inches. Published by DODD, MEAD AND COMPANY, 443–449 Fourth Avenue, New York. Price $1.50.

Prairie dog towns of the vast western plains have always interested the traveler. The dense population within a limited area attracts the eye, while semisocial behavior in the town appeals to the member of the human species who in his innermost spirit yearns for a happy life in a comfortable social setting. Between radio news briefs he may even wonder whether the prairie dog may not have beaten him to such an ideal existence.

Prairie Dog Town was written for the young mind to whom the world is still fresh and new. However, it is so replete with vivid incidents of prairie dog life that its story is equally interesting to the adult reader. The little volume is the product of a trained and experienced writer of juvenile stories and of an artist-naturalist, an entomologist by profession. The paper jacket states that "Margaret T. Raymond has red hair, green eyes and freckles," a combination of physical characters that one associates with a perennially youthful point of view. She is a widely recognized authority in the field of juvenile literature. Doctor Carl O. Mohr of the entomological staff of the Illinois State Natural History Survey is a mammalogist and artist by avocation. It was he who studied prairie dog towns and who prepared the pen sketches and data on which the story of prairie dog life is based. The remarkable photographs, truly personal portraits, of prairie dogs are the work of J. W. Jackson, a Colorado photographer of wild life, who used a specially built camera that could be operated from an automobile as a blind. The double-page photograph of five "Baby Prairie Dogs" is one of the most fascinating wild life pictures we have seen. It will rate as a classic in the field of animal portraits.

Prairie Dog Town is not in conventional chapters or even with captions. The text is built around the series of descriptive illustrations. The tale starts one February with the spring awakening from hibernation of a mother prairie dog and traces the experiences of the parents and their brood through the summer, through the following winter hibernation and ends with some incidents of courtship of a son and the daughter of a neighboring family the second spring. Woven into this interesting story are experiences with prairie dog friends and enemies, the burrowing owls, hawks, rattle-snakes, ferrets, rabbits, badgers, wolves and even the prong-horn antelope.

In our own search for good juvenile natural history we have given Prairie Dog Town AAA1 rating.—C. H. K.

I. THE CLASSIFICATION OF THE GENUS DROSOPHILA, ETC., by A. H. STURTEVANT, Calif. Inst. Tech. Pages 1–51.

II. NEW SPECIES OF THE QUINARIA GROUP IN THE SUBGENUS DROSOPHILA, by W. P. SPENCER, Wooster College. Pages 53–66.

III. NEW SPECIES OF THE SUBGENERA HIRTODROSOPHILA AND DROSOPHILA, by J. T. PATTERSON AND M. R. WHEELER, University of Texas. Pages 67–109. THE UNIVERSITY OF TEXAS PUBLICATION, No. 4213, April 1, 1942; pp. 1–109. Paper Bound. University of Texas, Austin, Texas. Price $1.00.

In this publication fifty-two new wild species of Drosophila are described. After twenty-five or more years of the laboratory study of Drosophila mutants reared in bottles various geneticists are exploring the wilds in a study of the species of that genus as they occur in nature. The problem of natural species-formation is being attacked directly. We call the attention of entomologists in general to the work of this group of entomologists who prefer to be called geneticists. The three contributions are straight taxonomy but are advanced taxonomy in that they include notes on internal anatomy. Other taxonomists might well study this publication because of its advanced ideas as to what constitutes a useful description.—C. H. K.

SYSTEMA APHIDIDAE. A GUIDE TO THE PHYLOGENY OF THE APHIDS OR PLANT LICE. Part One, THE LACHNEA. By O. W. OESTLUND. Pages i-v and 1-78. 6 x 9 inches, cartridge paper cover. Published by the AUGUSTANA BOOK CONCERN, Rock Island, Ill. Price $0.60.

This is the result of a lifetime devoted to an attempt to work out a logical system by which aphids can be classified into the many categories from family to subspecies. Because of the several forms in each species and the involved life histories the description of a species of aphid has become one of the very complex and highly conventionalized descriptions used in insect taxonomy. The present work is a philosopher's attempt to put some order into a system which has arisen by small accretions and constant rearrangement. Whether the author has succeeded in giving taxonomists a better system will have to be found out by trying out the Oestlund system on problems of aphid taxonomy under any and all conditions.

The author sets up a series of eight terms for known characters in aphids and aphid life histories so these do not need to be repeatedly described. By combinations of these expressions he erects "a key to the relative position of the various categories in the family higher than genus and species. All possible combinations (of these expressions) give 16 stages in the evolution of the category considered." This scheme has always taken the reviewer's eye. Once we erected such a scheme of combining characters to describe a series of species in the genus Agrion (Odonata). We found one combination missing. It was described a few years later from southwestern Asia. But we had not prophesied by publication! The present work in genetics suggests the possibility of the use of such schemes in group analyses. Probably those entomologists who call themselves geneticists will beat us to its use.

Whether we like it or not things are changing in the methods used by taxonomists. Describers of parasitic Hymenoptera demand a statement of the host animal or in cynipids, the host plant and in the latter case a description of the gall. On another page we "notice" a work on new species of Drosophila where internal parts are described. All students of social insects recognize areas where the habits of some wide-spread morphological species differ markedly from the habits of the species in the type locality. Social insects have evolved farther in habits, physiologically, than they have evolved morphologically. Thus such physiological variants are good "physiological species." But try to give a species name to such social groups without citing some minute difference in color or nature of vestiture. The first museum reviewer will throw it into synonymy because of his ignorance of the positive live differences. However we have come face to face with such problems. The students of aphids are as squarely up against the problem as are the students of social and parasitic insects. Thus in taxonomy physiology is making its impression on old-line museum morphology. How soon these changes will be recognized, if ever, by international committees on nomenclature no one can say.

The reviewer does not have a sufficient knowledge of aphid taxonomy nor sufficient space to analyze the Oestlund system. However, he advises all addicts of taxonomy to acquire a copy and study its methods of attack on the problems involved. It is worth considerable study. We do not like the displacement of tried terms such as "genotype" by the term "nucleus" or the use of "epoch" for a series of related genera. Such unnecessary innovations can only prejudice the entomological student against the use of the system's good elements. Philosophers and reformers still get short shift in this barbaric world.

We recommend the book for painstaking and thoughtful study. It is a bold and logical effort in a difficult field.—C. H. K.

COTTON INSECTS OF THE UNITED STATES, by V. A. LITTLE and D. F. MARTIN. ii×130 pages; 12 illustrations. 1942. BURGESS PUBLISHING COMPANY, Minneapolis, Minn. Price, $2.25.

The authors are to be complimented on bringing together in one volume and presenting in a well-organized manner the widely scattered information on this important group of insects in the United States.

The book is divided into two parts, the first being the insects attacking squares, blooms and bolls; and the second on the pests of foliage, stems and roots. Detailed information on each pest or group of pests is presented in the following manner: Economic Importance; Origin, History, and Present Distribution; Food Plants; Description of Life Stages; Life History; Control Measures, Natural and Applied; Literature Cited. Deviation from the above is followed for the less important pests.

The book is neatly printed by the offset process and is illustrated by twelve figures taken from experiment station or U.S.D.A. publications. A table of contents precedes the information section and an index is appended.

The book will be an invaluable aid to teachers of entomology, and the agricultural workers on research and extension staffs of the state and federal governments. Publications of this kind should be encouraged.—R. H. D.

GENERAL ENTOMOLOGY, by S. W. FROST. Pages x and 524, 406 figures. 1942. Size 6¼ x 9¼ inches. Published by MCGRAW-HILL BOOK COMPANY, INC., 330 West 42nd St., New York. Price $4.00.

This volume is by one whose life has been devoted to study of the habits of insects. Frost has not been particularly interested in collecting endless exact (?) data while the frightened insect scrambled through a maze, nor has he observed with cool unbiased mind the drunken activities of insects in a superheated chamber or in the last throes of death while suffering from some carefully applied poison. Exact data! While reading "General Entomology" the term "exact data" recedes into the background of the reader's mind and he wanders contentedly through the many pages on the interesting things that insects do when they feel free to do just as they please. It is a volume from Fabre's point of view. (Curiously enough, Fabre's reputation as a great entomologist persists though he never attempted to express his reputation in a mathematical formula.)

It is an interesting comfortable book where the reader never hesitates to turn the next page for fear that he may meet a formula that is 2^n times his mathematical ability. (In spite of all which comfort in entomology we advise our students to have at least one year in the calculus to comprehend the variables in insect structure and conduct.)

The material is organized in twenty-three chapters: I. Position of Insects in the Animal World; II. Origin and Distribution of Insects; III. Abundance, Size and Reproductive Capacity; IV. Beneficial and Injurious Insects; V. Orders of Insects; VI. Metamorphosis; VII. Immature Insects; VIII. Morphology; IX. Color; X. Sonification; XI. Behavior; XII. Associations, Including Social Insects; XIII. Solitary Insects; XIV. Scavangers, Predators and Parasites; XV. Plants and Insects; XVI. Leaf-mining Insects; XVII. Leaf-rolling Insects; XVIII. Gall Insects; XIX. Boring Insects; XX. Subterranean Insects; XXI. Aquatic Insects; XXII. Case-making Insects; XXIII. Cessation of Activity.

The illustrations are well chosen and many are from the author's earlier volumes on the habits of insects. We do miss those very excellent illustrations of the C. V. Riley reports which have come down in entomological books to near recent times. Perhaps entomological illustration has at last turned a corner.

General Entomology is a volume that organizes a great mass of data that will be of much use to entomologists and particularly to teachers. For once we have a volume on the behavior of insects which is scientific and to be so is not three-fourths on aquatic forms. Following each chapter is a bibliography of one to six pages which makes the work an effective key to the literature. How many times we have wished for such in our own teaching of the biology of insects.

This is a volume that every working entomologist could read with benefit. It would review for him the whole field of insect activities and might suggest answers for some of the gaps in his own results when acquiring such knowledge by laborious research.

General Entomology is one of the "McGraw-Hill Publications in the Zoological Sciences." Thus it rates as one of a series of outstanding works in biology. It has the sturdy binding, excellent type face, and fine paper of this series.—C. H. K.

A LOT OF INSECTS, by FRANK E. LUTZ. Pages 1–304, 80 illustrations. 1941. Published by G. P. PUTNAM'S SONS, 2 West 45th St., New York. Price, $3.00.

The Annals gave a notice of "A Lot of Insects" (p. 772) in the December, 1941, issue. Its price quoted from the earliest advertising circular was given as $3.50. A letter from the author points out that the volume was actually published at $3.00. As this was our first experience with such a preliminary reduction the Editor was caught asleep when the three dollar notice arrived, probably in the early afternoon mail.—C. H. K.

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OÖSORPTION AND OVULATION IN RELATION TO OVIPOSITION IN THE PARASITIC HYMENOPTERA[1]

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In the parasitic Hymenoptera the gravid female deposits few, if any, eggs except in response to a certain complex or chain of stimuli which are host-connected. When conditions are favorable for oviposition, the number of eggs that each species places on each individual host is fairly constant and is largely independent of host density; this in spite of the fact that in gravid females oögenesis, if not complete before emergence, may be continuous and proceeding at a constant rate.

The apparent restraint in oviposition on the part of the searching female insures the reproduction of the species when hosts are scarce. The isolated host, discovered after prolonged searching, usually receives the normal number of viable eggs, that is, the number that can develop and emerge from one host individual.

The morphological and physiological conditions in the female which may govern this selective action are outlined in this presentation.

It is convenient to classify the eggs of the parasitic Hymenoptera on the basis of the utilization of the embryonic membrane in obtaining nourishment from the host's fluids; a phenomenon herein designated *hydropy*. Eggs in which the embryonic membrane becomes xenotrophic in function are *hydropic;* eggs in which the embryonic membrane does not assume this function are *anhydropic*. See plate I, figs. 1 and 2.

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Hydropic eggs (plate I, fig. 1) may be deficient in yolk or almost devoid of it (alecithal). The growth of the trophic membrane causes the egg to increase enormously in size (Jackson, 1928). In some species the egg hatches precociously, that is, when the embryo is in the protopod stage of development (Imms, 1937). Hydropy has been observed in many species of endoparasitic Hymenoptera since Henneguy (1892) noted it in *Smicra clavipes*. It is noteworthy that hydropy is a prerequisite of polyembryony.

In anhydropic species there is no discontinuity in the development of the egg and embryo if conditions are favorable for the deposition of all ripe eggs; consequently the ovulated egg must be deposited before it hatches. Since the germarium as a rule is not depleted of oögonia before the death of the female, the number of eggs available at any time for deposition is fairly constant.

TABLE I

EXAMPLES OF HYDROPIC AND ANHYDROPIC SPECIES

Family	Hydropic Species	Anhydropic Species[5]
Chalcidoidea[3]. . . .	*Quaylea whittieri* (Gir.) *Coccophagus capensis* Comp. (female)	*Metaphycus lounsburyi* (How.) *Coccophagus capensis* Comp. (male)
Ichneumonoidea.	*Therion morio* F. *Apanteles glomeratus* (L.)	*Pimpla instigator* F. *Microbracon brevicornis* Wesm.
Serphoidea[4].	*Scelio pembertoni* Timb.	*Lygocerus niger* How.
Cynipoidea[4].	*Ibalia leucospoides* Hoch.	

[3] Species observed by the writer.

[4] The embryo may hatch when in the protopod stage of development in certain hydropic species.

[5] The anhydropic group includes many endoparasitic species. In *Coccophagus ochraceus* the fertilized egg develops endoparasitically and the unfertilized egg ectoparasitically on lecaniine scale insects.

In hydropic species the eggs are comparatively small. Ripe eggs may be stored pending their deposition in the paired oviducts and in the basal portion of the ovary. In some species the germarium may be depleted of oögonia either before or soon after the female emerges, ovulation occurring as rapidly as the eggs become ripe. In such species the oviducts are adapted for the storing of a large number of eggs.

It is obvious that the apparent restraint in oviposition in many hydropic species is dependent in part at least on the capacity for the storing of ripe eggs. This storage capacity is very limited or lacking in anhydropic species, yet they also exhibit restraint in oviposition. It seems that this ability in species that lack storage capacity is an effect of the sorption of the ripe egg while it is enclosed in its follicular membrane. When hosts are lacking, oösorption occurs at the same rate as oögenesis. Ovulation in anhydropic species is dependent on an external stimulus and precludes oösorption only when conditions are favorable for oviposition. This is the case also in hydropic species that lack the capacity for storing eggs.

OÖGENESIS

Oögenesis in the Hymenoptera proceeds in the ovariole in a line comparable to line production in modern industrial operations. The material used in the fabrication of the ovarian egg consists largely of the nitrogenous food consumed by the female during its larval or adult life. In many of the anhydropic species the food consumed and stored during the larval period is insufficient for the development of its supply of oögonia. The adult female of such species habitually feeds on the body fluids of its developmental host. This habit, according to Clausen (1940), is known to occur in species representing about 25 families of parasitic Hymenoptera. It seems to be absent in hydropic species.

In some species, as in the pteromalids, *Spintherus*, *Dibrachoides*, and *Peridesmia*, parasitic on the alfalfa weevil, *Hypera postica* (Gyll.), host feeding by the newly emerged adults must precede oviposition. In a large number of host-feeding species, however, the female, as in *Metaphycus helvolus*, is able to deposit a few eggs before commencing to feed on host fluids. Host-feeding females as well as many non-host-feeding females require carbohydrates, such as honey, nectar, or honeydew, for total oviposition.

In the absence of hosts, the females of species in which oögenesis is dependent, entirely or in part, on host-feeding during the adult stage, appear to have fewer ripe eggs in the ovaries at a time and to be longer-lived than those in which complete oögenesis is independent of such host-feeding.

Oögenesis in many, if not most, anhydropic species of Hymenoptera may proceed without interruption until the death of the female. The habit of the adult female of feeding on nitrogenous food, however, is correlated, in some species, with the *temporary* cessation of oögenesis, which may occur either spontaneously or as a result of environmental conditions.

In such cases, oögenesis may either stop or start through the influence of other factors. In the social wasps, Marchal (1896) observed that workers became fertile merely as the result of the "*suppression de la reine*." In the pteromalid *Peridesmia phytonomi*, a species in which ovarian maturation is dependent on host-feeding of the adult female, oögenesis may cease while the female is feeding daily on host fluids (Flanders, 1935). Recent studies of the parasites of black scale, *Saissetia oleae* (Bern.), show that in the case of *Metaphycus helvolus* Comp. the cessation of oögenesis occurs only when there is a lack of hosts.

Thompson and Parker (1928) observed in *Melittobia acasta* that starvation of gravid females resulted in the cessation of oögenesis and that when starved females were provided with nourishment, oögenesis was resumed. During the starvation period the eggs in the lower part of the ovaries became disorganized and were apparently absorbed. In this species the lack of sperms in the spermatheca tends to inhibit oviposition. When the spermatheca is depleted of sperms, a few unfertilized eggs may be deposited before oösorption sets in.

OVIPOSITION IN RELATION TO OVULATION

If the leading oöcyte is not absorbed, it passes into the oviduct. In most anhydropic species the egg is deposited immediately thereafter. In a few ectoparasitic forms, however, deposition may be delayed and "uterine incubation" occur. Such eggs may be deposited at random. It is noteworthy that the queen bee, deprived of cells in which to oviposit, may deposit several dozen eggs at random.

The necessity for the elimination of all eggs from the oviducts of anhydropic species is exemplified in the ichneumonid genus *Paniscus*. Embryonic development in certain species of this genus may be completed while the egg is in the oviduct. Histogenesis does not inhibit the discharge of the eggs since they pass out through a cleft at the base of the ovipositor (Vance, 1927). Several instances have been observed in which the death of the parasitic female resulted from the perforation of the wall of the oviduct by the larvae (Chewyreuv, 1912).

In hydropic species, ripe eggs may be stored in the enlarged oviducts pending conditions suitable for oviposition. Some, if not all, of the eggs may leave the ovarioles as rapidly as they are formed, independently of any external stimulus.

Pampel (1913) observed that in the "*Ophion*" type of ichneumonids such as *Campoplex*, *Angitia*, *Glypta*, *Trichomma*, etc., each of the paired oviducts is enlarged to form a "*Sammel-reservoire*" (plate I, fig. 3) for the storing of eggs. The oviducts in the "*Apanteles*" type of endoparasitic braconids (plate I, fig. 4) also are well developed for this purpose, particularly in the Microgasterinae and Cheloninae.

The paired oviducts of *Apanteles* spp., just prior to emergence of the female from its cocoon, are swollen and filled with a mass of cells (possibly mycetocytes). Oögenesis in the ovarioles is accompanied by a decrease in the numbers of these cells beginning at the base of the oviduct. The space in the oviduct vacated by the cells is concurrently filled with a

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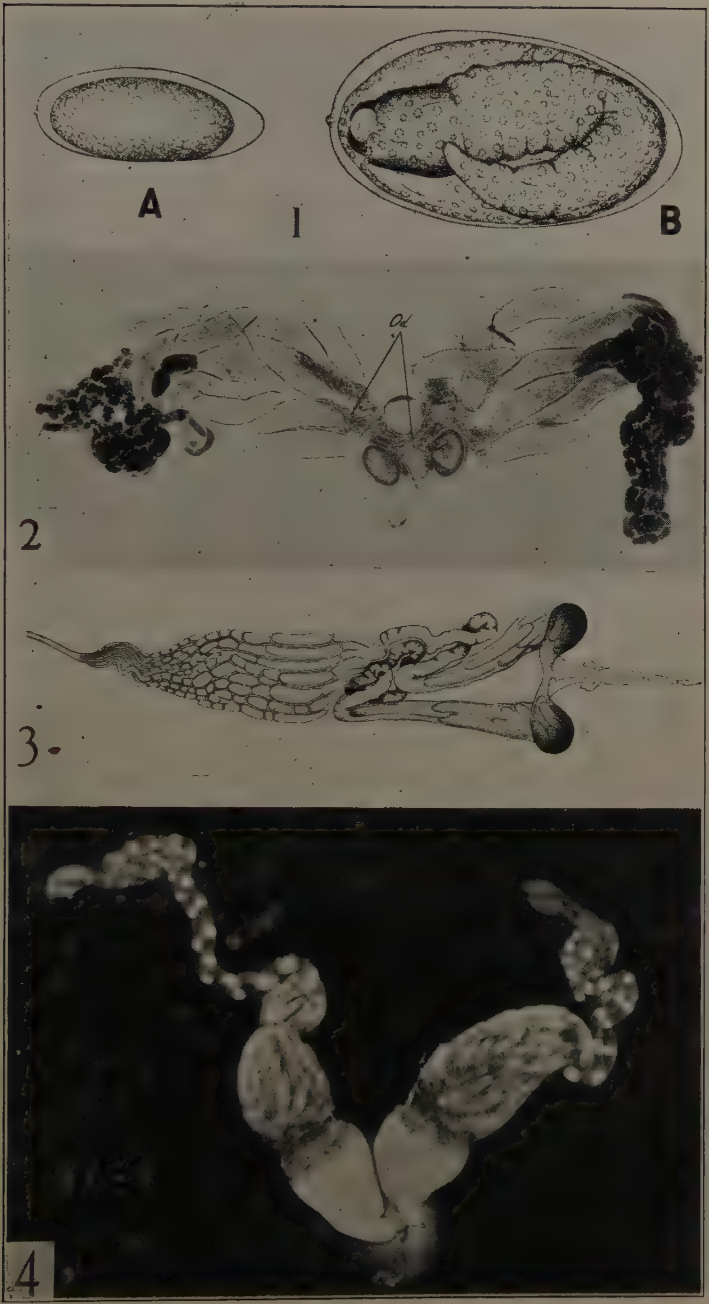
EXPLANATION OF PLATE I

Fig. 1. The hydropic egg of *Helorus paradoxus* Prov. showing trophic membrane. *A*, newly deposited egg. *B*, egg just before hatching. (After Clancy from Clausen, 1940.)

Fig. 2. The reproductive system of *Pteromalus puparum* L. with anhydropic eggs in the ovarioles. Note the short oviduct (Od).

Fig. 3. The reproductive system in the female of *Ophion luteus*. Note the enlarged oviducts for storing eggs. (After Pampel.)

Fig. 4. Ovaries of *Apanteles* sp., showing the enlarged oviducts filled with a milky fluid which apparently results from the conversion of cells (mycetocytes?) that filled the lumen of each oviduct. *S*, spermatheca.


A
1
B
Od
2
3
4
s

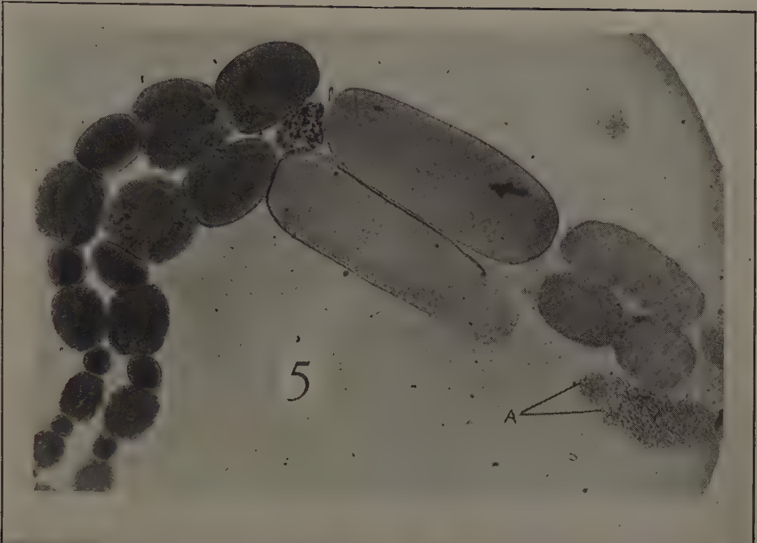
EXPLANATION OF PLATE II

Fig. 5. Two ovarioles from a queen bee, showing the disintegration of the ripe eggs. *A*, the posterior yellow portion of a disintegrating egg. (The queen bees used in this study were supplied by J. E. Eckert, Associate Professor of Entomology and Associate Apiculturist in the Experiment Station, University of California.)

Fig. 6. Basal portion of the ovaries of *Dibrachoides dynastes* (Foerster) 75 days after emergence. *X*, ripe eggs in the process of sorption.

Fig. 7. Ovaries of *Peridesmia phytonomi* in state of castration, one month after emergence of female. Note that the germaria remain intact.

Fig. 8. Ovary of *Metaphycus helvolus*. Female withheld from host for 25 days and fed on a mixture of honey and host fluids. Note outline of the exochorion of the posterior body and neck of disintegrating egg. Anterior body has disappeared. The exochorion collapses and forms an egg remnant (fig. 9) in the form of a pellet.



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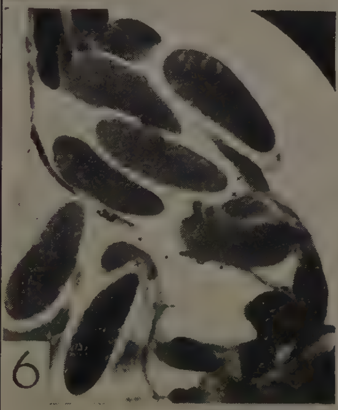

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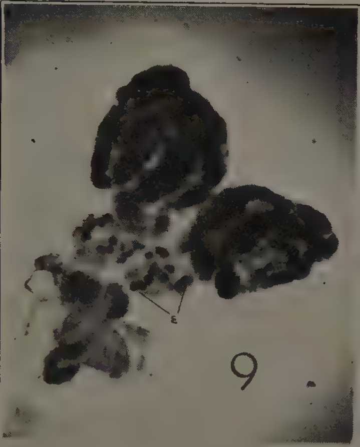
EXPLANATION OF PLATE III

Fig. 9. Ovaries of *Metaphycus helvolus* when in a state of castration. Female withheld from host for 28 days at 80 degrees F. The number of egg remnants (e) in each pedicel indicates that 4 to 7 eggs matured and disintegrated in each of the 6 ovarioles.

Fig. 10. Ovary of *Clausenia purpurea*. *R*, "rings" which are remnants of the eggs absorbed. Each ring had encircled the neck of the double-bodied ovarian egg. The rings accumulate in the basal portion of the ovarioles. *S*, spermatheca.

Fig. 11. Exochorion of the posterior body and neck of an egg of *Encyrtus fuliginosus* after extrusion into the body cavity. The follicular cells enclosing the egg remnant gradually disappear. In this species the exochorion remains undigested.



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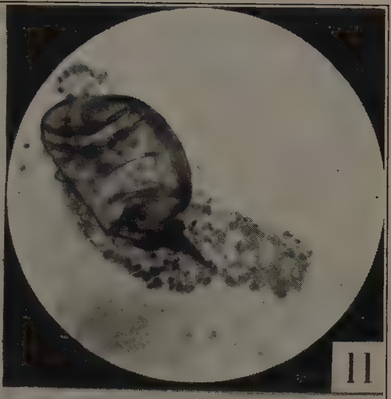

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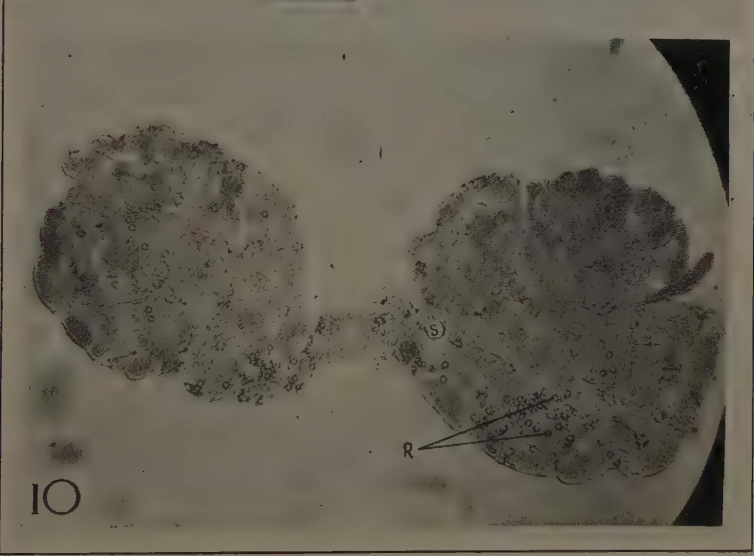

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milky fluid. About a week after the emergence of the female, the cells have disappeared and the milky fluid fills not only the pouch-like oviduct but the enlarged bases of the two ovarioles so that the oviduct and ovarioles together form a paired chamber or uterus, filled with eggs.

The function of this milky fluid is unknown. Under high magnification it appears to be a mass of extremely small, motile bacteria. This material may serve to retard oösorption in the bases of the ovarioles and maintain the eggs in a healthy condition pending deposition. The outer surface of the oviduct is covered with a sheathing of very fine lengthwise muscle fibers. The enlarged muscular pouch, the small eggs and the short ovipositor permit extremely rapid egg deposition.

Since development is stimulated only by substances present in the host, the eggs in the oviducts may remain in a quiescent condition during the life of the female. It is significant that in the great majority of braconid species of endoparasitic habit the egg is hydropic, increasing in size because of the absorption of host fluids by the embryo (Clausen, 1940).

The storage of ripe eggs in muscular oviducts is correlated with the ability to discharge a large number of eggs quickly during one insertion of the ovipositor or a large number singly if hosts are available. This rapidity of egg deposition probably is responsible for the fact, pointed out by Clausen (1940), that an exceptional number of braconid species yield a preponderance of male progeny.

In anhydropic species with short oviducts (plate I, fig. 2), ovulation occurs when environmental conditions are favorable for immediate egg deposition so that the rate of oviposition may be governed by the number of ovarioles (Clausen, 1940). In gregarious species, the number of eggs deposited per host may be influenced by the number of ripe eggs in the ovarioles.

In the hydropic species of *Ascogaster*, when hosts are lacking, a portion of the eggs is stored in the oviduct; then ovulation ceases and oösorption takes place in the ovarioles.

OÖSORPTION IN RELATION TO OVIPOSITION

The sorptive process in insects generally may be largely limited to the discarded egg follicles. In worker ants, however, the sorption of developing eggs has been described by Weyer (1927). He also observed that this occurred in certain wasps and in the honeybee (plate II, fig. 5). The disintegration of ripe eggs was noted by Smith (1932) in the ichneumon *Phaeogenes nigridens*. Smith's observations indicate that oösorption began in less than 10 days after the egg reached maturity.

Recently, I have observed that when certain parasitic Hymenoptera are withheld from their hosts, the processes of oösorption and oögenesis occur synchronously and enable the female, after a period of inhibited oviposition, to deposit viable eggs as if no interruption had occurred. In the prolonged absence of hosts, species in which ovulation is stimulated externally may maintain their reproductive capacity by complete oösorption and cessation of oögenesis. Such species are then in a condition of "phasic castration" (Flanders, 1935, p. 442). In other words, the function or development of gonads is temporarily inhibited.

As Lloyd (1940) has observed in the case of the ichneumonid *Diadromus collaris*, the number of eggs deposited daily may be unaffected by periods of inhibited oviposition. In several species of chalcidoids parasitic on the black scale, the substitution of oösorption for ovulation during periods of isolation apparently maintains the normal oviposition curve.

The observations substantiating this thesis have been made on several species of pteromalids parasitic on the alfalfa weevil (plate II, figs. 6 and 7) and on several encyrtids parasitic on the black scale (plate III, figs. 9 and 11). In the case of the pteromalids, oösorption may be followed by a long period of castration which begins and ends spontaneously. The encyrtids, on the other hand, lacking spontaneous castration, having very short life cycles, and being readily propagated, were better subjects for investigation.

Over 200 encyrtid females were dissected, and stained preparations were made of the ovaries. Observations on oösorption were made possible by the peculiar structure of the encyrtid egg. This egg, in the ovary, is double-bodied and, in the encyrtids under observation, possesses on the neck and posterior body a rigid band or aeroscopic plate, which seems to be superimposed on the exochorion (Maple, 1937). When the sorption of the double-bodied egg is complete, its contents and the entire anterior body have disappeared, leaving only the aeroscopic plate and all or part of the exochorion (plate III, fig. 9).

The aeroscopic plates remain more or less intact and form recognizable remnants of the ripe eggs. Such is the case when *Encyrtus fuliginosus* Comp., *Metaphycus stanleyi* Comp., *M. lounsburyi* (How.), *M. luteolus* (Timb.), *M. helvolus* Comp., *Clausenia purpurea* Ishii (plate III, fig. 10), *Habrolepis rouxi* Comp., and *Oöencyrtus johnsoni* (How.) are isolated from their host for a week or more at 80° F. A study of these species shows that oögenesis and oösorption occur synchronously and form a cyclic process which maintains a more or less constant number of ripe eggs in the ovarioles.

The egg remnants were retained in the ovarioles in most of the species examined. In *Encyrtus fuliginosus*, however, the complete exochorion of each disintegrated egg (plate III, fig. 11) appeared to have been extruded into the body cavity. In every female dissected, from 10 to 100 exochorions were found free in the body fluids. The presence of a cellular mass surrounding some of these egg shells indicates that in this case ripe eggs may be set free in the body cavity before oösorption is completed.

In this connection it is of interest to note that Thorpe and Jones (1937), in their studies of the ichneumon *Nemeritis canescens*, found dead first-stage larvae in the body cavities of gravid females. In this case, however, it seemed "fairly certain" that the eggs from which these larvae emerged were deposited by other females enclosed in the same cage, since they were frequently seen to stab one another with their ovipositors. This reaction occurred when the females were withheld from their normal hosts. Oösorption within the body fluids may have been prevented by the glandular secretion with which the eggs are coated as they pass through the oviduct (Flanders, 1934).

The ovarioles in *Encyrtus fuliginosus*, a species with non-host-feeding adults, contained a relatively large number of developing and ripe eggs, and there was little space in the base or pedicel of each ovariole for the storage of egg remnants. Consequently, the large number of exochorions found in the body cavity before and after oviposition indicates that they were extruded through the *tunica propria*, the structureless elastic membrane covering each ovariole. It is significant that ovipositing females of *E. fuliginosus* live three times as long as those that are not permitted to oviposit.

Nonviable eggs in the process of disintegration, but with the chorion intact and enclosing fluid material, may be deposited. A female of *Metaphycus luteolus*, withheld from its host for 3 weeks at 80° F., deposited both viable and nonviable, partially collapsed eggs. The ovaries of a female 4 weeks old contained developing eggs, 4 ripe eggs, and the collapsed exochorions of at least 75 ripe eggs.

Exochorions or egg remnants apparently never pass into the oviducts and consequently cannot be discharged through either the ovipositor or the copulatory opening. The accumulation of egg remnants in the pedicel, which occurs in many species, apparently does not interfere with ovulation.

The structure of the encyrtid egg precludes maturation prior to oviposition.

APPARENT RESTRAINT IN OVIPOSITION

Several investigators have shown that certain parasites distribute their eggs, not at random, but with reference to the nature of the host available at the time. Lloyd (1938) points out that the exercise of this selective faculty is dependent on the ability of the female to restrain oviposition. In his study of *Oöencyrtus kuvanae*, he found that the faculty of restraint broke down when the accumulation of ripe eggs in the ovaries reached a certain number. This occurred four days after emergence of the adult. Yet Lloyd states that "Surprisingly, when the inhibition of oviposition was extended beyond the first four days of life, restraint again became evident so that females which had been kept 10 days before being given hosts showed greater restraint than the younger females." He assumed, as have previous investigators, that the ripe eggs remained in the ovaries or oviducts until deposited. This assumption seemed verified when he found experimentally that inhibition of oviposition did "not affect the ultimate output of mature eggs provided sufficient hosts were available. . . ."

In encyrtids that are withheld from their hosts from the time of their emergence, the number of ripe eggs in the ovaries reaches a maximum within a few days. This number, however, is less than the maximum which may occur in females that have been ovipositing for several days. When such a female is withheld from its host, the ripe eggs may accumulate in the ovaries, nullifying for a short period its ability to discriminate between hosts. Subsequently, if hosts are scarce oösorption sets in and forms a cyclic process with oögenesis, so that the number of eggs that reach maturity each day is fairly constant and not excessive. As a result, the female of the anhydropic species is able to exercise a restraint in oviposition and a choice of hosts. The faculty of oösorption therefore plays an important part in host selection and influences the efficiency of parasitization.

The females of anhydropic species may lose the ability to respond to oviposition stimuli if withheld from the host for a long time. Jackson (1937) observed that a female of the ichneumonid *Pimpla examinator*, when placed with its host after being isolated for 6 weeks, made no attempt to oviposit. Nevertheless, when dissected 2 weeks later, the presence of several "regressed eggs" indicated that oösorption was taking place.

In anhydropic species oösorption may preclude ovulation. This may account for the fact that in such species the responsiveness to oviposition stimuli appears to be a function of the frequency of oviposition.

There appears to be a distinct correlation between the degree of restraint in oviposition and the preponderance of female progeny (Flanders, 1939). This is exhibited to a marked degree in the Serphoidea (Clausen, 1940). Most of the endoparasitic species of this group probably are hydropic.

THE ROLE OF OÖSORPTION IN METAPHYCUS HELVOLUS

Since *Metaphycus helvolus* is an effective parasite of black scale, it has been studied in considerable detail. Introduced and established in California in 1937 by the University of California Citrus Experiment Station, under the direction of Professor Harry S. Smith, it now appears to be controlling the black scale throughout a large part of the state. The efficiency of this parasite may result, in part, from its ability to maintain its reproductive capacity during the prolonged absence of suitable hosts.

The normal development of the gonads in *Metaphycus helvolus*, unlike that in *Encyrtus fuliginosus* and *Metaphycus stanleyi*, is dependent on host-feeding by the adult female, since the food consumed as a larva is not sufficient for the maturation of its complement of oögonia. Oögenesis is continuous if the intervals in contacting individual hosts are not prolonged.

When the newly emerged female is isolated at a constant temperature of 80° F. and fed only on honey, oösorption begins within 3 days after emergence. Oögenesis ceases, and oösorption is complete 3 to 4 weeks after emergence. In each of the ovarioles, 4 to 7 eggs may have matured and disintegrated (plate III, fig. 9). A period of phasic castration then ensues, which ends, not spontaneously as in the pteromalids previously studied, but when contact is made with the host and the female feeds on its fluids.

When females, in a state of castration, were placed with their hosts 30 days after emerging, they began ovipositing 3 days later and deposited up to 408 eggs at the rate of from 1 to 16 per day. This production required feeding at intervals on host fluids, usually after the deposition of 1 to 5 eggs.

Phasic castration, however, does not occur if hosts are available for oviposition. The ovaries of newly emerged females of *Metaphycus* *helvolus*, feeding on host fluids and honey,[6] contain no ripe eggs on the first day but may have 2 ripe eggs in each ovariole on the fourth day after emergence. Only 1 egg occurs at a time in each ovariole in females that have not fed on host fluids. A female which had been allowed to oviposit and feed on host fluids for 8 days was prevented from doing so for 24 hours and then was dissected. Each ovariole contained 3 ripe eggs. At a constant temperature of 80° F., the average number of eggs deposited daily may be as high as 12 by each female. One female produced 740 eggs, ovipositing daily over a period of 60 days. In this case, the maximum daily deposition was 18 eggs. The ovaries of females that die when hosts are available usually are entirely depleted of oöcytes and oögonia.

In *Metaphycus luteolus*, a closely related species parasitic on the same stages of black scale and having habits of development, oviposition, and feeding similar to those of *M. helvolus*, oögenesis does not cease during the life of the female. Phasic castration, therefore, apparently does not depend on either the kind or quantity of food consumed. It is significant that, regardless of the age of the castrated female, the period between contacting the host and ovipositing in it varies but little.

The feeding on host fluids that must precede oögenesis tends to increase the effectiveness of *Metaphycus helvolus* because the proportion of hosts destroyed by such feeding increases as the host density diminishes.

In this species, at a temperature of about 80° F., a primary germ cell (oögonium) becomes a ripe egg in less than 3 days. Oösorption requires considerably less time than oögenesis; probably only a few hours.

SUMMARY

In the parasitic Hymenoptera, the occurrence of oösorption prior to ovulation and the storing of ripe eggs after ovulation are adaptations for maintaining the reproductive capacity of the species when environmental conditions are unfavorable for oviposition. Eggs may be stored for periods longer than that necessary for incubation only when they are hydropic, that is, when they lack nutritive substances necessary for embryonic development.

In a certain species of *Apanteles*, the ovary and its oviduct are modified for storing its full quota of eggs.

The fact that the ripe eggs of certain species of encyrtids possess structures which are not absorbed provided proof of the synchronous nature of the oögenic-oösorptive processes that occur in many Hymenoptera.

Oösorption was found to occur only when ovulation was inhibited.

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[6] According to Eckert and Allinger (1939), the average California honey consists of the following components, in percentages of the total: moisture, 16.50; total sugars, 77.53; levulose, 40.41; dextrose, 34.54; sucrose, 2.53; dextrin, 0.91; ash, 0.21; acid, 0.16; and undetermined, 4.72.

When there is a sequence of developing oöcytes in the ovarioles the leading or ripe egg is always newly formed, the preceding egg having disappeared, either through oösorption or ovulation.

Oösorption on one hand and the storing of ripe eggs on the other are adaptations permitting the restraint in oviposition which is so essential to host selection.

In the lecaniine scale parasite *Metaphycus helvolus*, the adult female of which habitually feeds on its host, the resumption of oögenesis after phasic castration is solely dependent on host-feeding.

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female sex organs

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A SYNOPSIS OF THE GENUS SCUTIGERELLA
(Symphyla: Scutigerellidae)

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For a number of years the writer has made an effort to obtain examples of the garden centipede, *Scutigerella immaculata* (Newp.) from different parts of the world. As a result, specimens of this genus have now been received from Europe and Palestine as well as from several localities in North America. An examination of this material has shown that several species are involved and that, in a number of cases, they have been previously referred to by various authors as *S. immaculata.* One factor contributing to this situation is the fact that *S. immaculata* is a variable species. Michelbacher (1938) has previously shown that individuals molt from time to time during their entire life. Following the sixth molt they have 12 pairs of legs and the full number of scuta, but additional changes occur with the following molts, and these are particularly marked during the seventh to eleventh instars. The number of setae occuring on various parts of the body increase, anatomical proportions change, antennal segments are added, and there is an increase in body size. Thus it is no wonder then that considerable difficulty may be encountered in properly placing a species.

The fourteenth scutum of the sixth instar individual has a pair of chitinous projections arising from the posterior margin. These are lost during the next molt, but the posterior margin of the scutum has a somewhat scalloped appearance. Complete differentiation does not occur in some specimens until after the twelfth molt. Figure 1 shows some of the variations which occur in the fourteenth scutum after the different molts.

When new species are described the descriptions should be made only from individuals in which the penultimate scutum is completely or nearly completely differentiated. All of the evidence at hand indicates that the various species of *Scutigerella* have similar stages of development.

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[1] It is with sincere pleasure that I express my appreciation to Professor E. O. Essig and Dr. E. Gorton Linsley for the help they have given me in the preparation of this paper.

From the material now in my possession I am here describing seven new species. Three of these are from Europe, three from the United States, and one from Palestine. This study suggests that the genus *Scutigerella* is comparatively rich in species and, as the symphylan fauna of the world become more thoroughly studied, many other species will undoubtedly be found.

There are a number of characters which are particularly useful in differentiating species. The scuta have excellent characters. Both their gross shape and the nature of the posterior margin are valuable. The scuta used in the descriptions below are the second, third, fourth, and fifteenth. It should be pointed out that the first scutum is very small, and that some workers including Hansen (1903) did not consider it in the assignment of numbers. Therefore, in this paper the scutum referred to as number two is the first large one, or the one which Hansen regarded as scutum one. The posterior margin of scutum two ranges from nearly truncate to deeply emarginate, depending upon the species. The number of marginal and sub-marginal setae on the scuta also vary greatly in different species as does the length of the setae. It should be pointed out, however, that in a given species some intraspecific variation in the number of marginal and submarginal setae occurs. The cavity associated with the terminal segment may be of some value. In mounted specimens it is either "U"

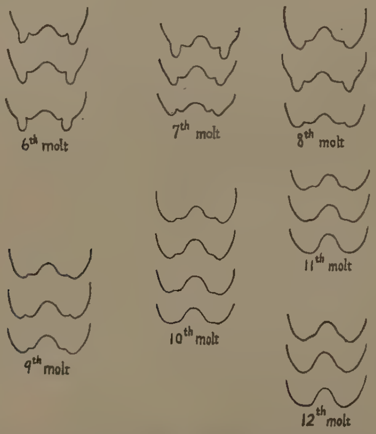

Fig. 1. Variations that occur in the penultimate scutum of *Scutigerella immaculata* in the sixth to the twelfth molts, inclusive. Note that it may be completely differentiated in the eleventh molt. (× 30). After Michelbacher (1938).

shaped or "V" shaped, and from the material at hand it would appear that the shape is constant for any species.

The cerci also offer good characters, particularly their length as compared to their width and their length as compared to the length of the head. Their shape is of some additional value and they may be either sparsely or densely clothed with setae. Further, the length of their setae varies in different species.

There are also leg characters that can be utilized. The length of the setae as well as whether the legs are sparsely or densely clothed with setae are probably of considerable importance.

There is little doubt but what there are good antennal characters, but these are rather difficult to utilize because the antennae are broken very easily. Under such conditions they are affected by regeneration and, in addition, during molting, segments are added so that in any species a wide variation in the number of segments is likely to occur. Despite this, there appears to be some specific tendencies. The maximum number of segments likely to occur in *S. linsleyi* is probably not more than half that to be found in some of the other species.

Among the head characters, the long seta inserted between the post-antennal organ and the spiracle is very important. It may be subequal to considerably longer than the greatest width of the third antennal segment.

The body length varies greatly for the different species. *Scutigerella linsleyi* is a very small species measuring 3.5 to 4 mm. as compared to *S. silvestri* which measures 7 to 9 mm.

Although there are only eight pairs of coxal sacs in most species, in *Scutigerella verhoeffi* there are nine. This might be considered a generic character and it may later be necessary to make *S. verhoeffi* the type of a new genus. Verhoeff (1933–34) reported that he had collected specimens of what he called *S. immaculata* with both eight and nine pairs of coxal sacs, but stated he was not sure whether he was dealing with a specific difference or with an individual or local variation. Ribaut (1931) has pointed out that the last three pairs of legs in *Scolopendrella*, *Symphylella*, and *Symphylellopsis* lacked coxal sacs, while in *Symphylellina*, *Geophilella*, *Scutigerella*, and *Hanseniella* they are lacking only on the last two. In *S. verhoeffi* they are absent only on the last pair of legs.

The styli have a few characters of value. The posterior styli in some species have a secondary lateral seta.

Mounting symphylans sometimes offers considerable difficulty. Exceptionally good mounts have been obtained by the writer when the specimens were cleared in ten per cent KOH, stained for 48 hours in acetic acid fuchsin, followed by washing in acetic acid, then running through acetic acid-clove oil to straight clove oil and mounting in balsam. When considerable material has been available some specimens have been mounted in a modified Berlese's medium to which iodine has been added. These latter mounts proved exceptionally good for study.

All measurements given in this paper were made from mounted material. Some slight variation in measurements has resulted depending upon whether the material was cleared, stained, and mounted in balsam, or whole mounts were made in the modified Berlese's medium. The Berlese's medium exhibited a tendency to cause lateral expansion of some structures such as the head.

The garden centipede, *Scutigerella immaculata* (Newp.), is the best known member of the class Symphyla. This is due, in part, to the fact that it is a very serious pest of cultivated plants. The species was named by Newport (1845) from specimens collected near London, England. In some places it occurs in abundance and has been reported as doing damage to crops grown under glass by Walton (1930), Kearns and Walton (1932), Miles and Cohen (1935), and Spyer (1935). In France it has been reported as a pest by Feytaud (1925, 1926) and Larrieu (1934). Mr. Feytaud has sent me specimens from Mugron. These examples are very similar to those that occur in North America where damage by the garden centipede has been reported. Not having an opportunity to study Newport's type; I am inclined to believe that the specimens from France, the species that is destructive in England, and the one that is a pest in North America all belong to Newport's species, and I am considering them as *S. immaculata*. This species, Plate I, figures 1a to 1i is characterized by being densely clothed with relatively short setae.

Although there are a number of species of *Scutigerella*, to my knowledge *S. immaculata* is the only one that is destructive to agricultural crops. Morphologically, at least, there seems to be no reason for this restricted behavior and, as our knowledge of the genus expands, it may be found that some of the other species are capable of doing damage. At the present time an effort is being made to obtain specimens from areas throughout the world where injury has been reported, in the hope of determining if other species are involved. The fact that *S. immaculata* attacks commercial plants may account for its wide distribution throughout much of the world. It is abundant in many nurseries and is easily transported where soil is moved from place to place.

KEY TO SPECIES OF SCUTIGERELLA

1. Posterior margin of second scutum deeply emarginate....................2
   Posterior margin of second scutum subtruncate or broadly, shallowly emarginate....................7
2. Femur of first pair of legs without a conspicuous ventral process....................3
   Femur of first pair of legs having a very conspicuous vertical ventral process, which is from one and one-half times to more than three times longer than broad....................**armata**
3. Second scutum with less than 48 marginal and sub-marginal setae....................4
   Second scutum with more than 52 marginal and sub-marginal setae....................6
4. Tarsus of last pair of legs sparsely set with setae; body length usually not more than 4 mm.; second scutum with not more than 38 marginal and sub-marginal setae....................**linsleyi**
   Tarsus of last pair of legs moderately densely set with setae; body length usually more than 4 mm.; second scutum generally with more than 38 marginal and sub-marginal setae....................5
5. Cerci with slight expansion in terminal area; sparsely set with setae, of which those at apex are slightly longer than those at the base; cavity of fifteenth scutum "U" shaped; body length 4.7 to 6.1 mm....................**nodicercus**
   Cerci without slight expansion in terminal area, densely set with setae of which those at apex are not appreciably longer than those at the base; cavity of fifteenth scutum "V" shaped; body length 4.1 to 5.4 mm. .**palmonii**
6. Cerci more than four times as long as greatest width, and as long as or considerably longer than length of head; posterior styli armed with a lateral seta; long seta between post-antennal organ and spiracle distinctly longer than greatest width of third antennal segment; body length 7 to 9 mm., **silvestrii**
   Cerci generally less than three and one-half times as long as their greatest width, and considerably shorter than length of head; posterior styli not armed with a lateral seta; long seta located between post-antennal organ and spiracle only about as long as the greatest width of the third antennal segment; body length less than 7 mm....................**immaculata**
7. Fourth scutum without a long lateral seta on either side....................8
   Fourth scutum with a long lateral seta on either side, its length equal to about the greatest width of the third antennal segment; body length 4.2 to 5.5 mm....................**inculta**
8. Second scutum truncate and with from 36 to 45 marginal and sub-marginal setae; cerci about three and one-half times longer than their greatest width; cavity of fifteenth segment "U" shaped; eight pairs of fully developed coxal sacs; body length 4.3 to 5.2 mm....................**causeyae**
   Second scutum barely emarginate and with more than 45 marginal and sub-marginal setae; cerci about four times longer than their greatest width; cavity of fifteenth segment "V" shaped; nine pairs of fully developed coxal sacs; body length 4.9 to 7.8 mm....................**verhoeffi**

Scutigerella biscutata Bagnall (Bagnall, 1914) has proven to be a sixth instar individual of *S. immaculata.* This was verified by specimens sent to Mr. Bagnall for comparison with his types.

The species *Scutigerella spinipes* Bagnall (Bagnall, 1914) is insufficiently described to be recognizable. I am inclined to believe that it is approximately a seventh instar individual of *S. immaculata* but I was unable to substantiate this through specimens sent to Mr. Bagnall.

Scutigerella silvestrii n. sp.

(Plate I, figs. 2a to 2i)

Head slightly wider than long, central rod (coronal suture) complete in its entire length, although less distinct in its anterior portion; lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present. Long seta located between post-antennal organ and spiracle distinctly longer than greatest width of the third antennal segment. Top of head set with setae of several lengths; between the lateral branches and the side of the head there are a number of very long setae; longest are about four times the length of the shortest setae found in the same general area.

Right *antenna* of the type broken, left of 33 segments. Antennae broken in most of the specimens examined. Largest number found in any specimen was 44, although more than this number can be expected to occur in the species. Second antennal segment with three setae on dorsal surface of which the outer one is much thicker and more developed than the others. Outer setae on other basal segments more strongly developed than those on inner side. On dorsal surface of third antennal segment just anterior to the primary row of setae and in medial position there is a strong short spine. In the type a similar spine is found on the fourth and fifth segment. Second whorl of setae starts on the tenth or eleventh segment. Apical segment with a large stalked organ set on a prominent base; a small sensory organ is also present. Organs similar to the latter may be found on dorsal surface and to the outside on all segments beginning with the fifth, sixth, or seventh to apical one. In prepared mounts the membranous anterior portion of the next to the last segment somewhat expanded.

The second *scutum* with about 55 marginal and sub-marginal setae, and with posterior margin rather strongly emarginate; third scutum with about 64 marginal and sub-marginal setae and with posterior margin rather deeply emarginate, fourth scutum with about 60 marginal and sub-marginal setae, and with its posterior margin emarginate. All three scuta with several long setae along the lateral edges. They are sub-marginal as compared to the shorter setae. The longest of these setae on second scutum about three times the length of the shortest

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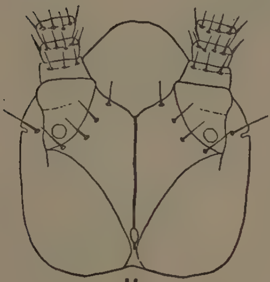
EXPLANATION OF PLATE I

Fig. 1. *Scutigerella immaculata* (Newp.). 1a, dorsal view of last two segments of antenna; 1b, head and first four antennal segments, only the long setae on anterior half of head and those on the antennal segments are shown; 1c, cavity associated with fifteenth scutum, only the setae in or close to the cavity are drawn in; 1d to 1f, second, third, and fourth scuta, only marginal setae and the longer sub-marginal setae are shown; 1g, posterior view of twelfth leg; 1h, cercus; 1i, stylus. (All × 68 except 1a, which is × 180, and 1i, which is × 90.)

Fig. 2. *Scutigerella silvestri* n. sp. 2a, dorsal view of last two segments of antenna; 2b, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 2c, cavity associated with fifteenth scutum, only the setae near or close to the cavity are shown; 2d to 2f, second, third, and fourth scuta, only marginal setae and the longer sub-marginal setae are shown; 2g, posterior view of twelfth leg; 2h, cercus; 2i, stylus. (All × 45 except 2a and 2i × 90.)

Scutigerella
A. E. Michelbacher

PLATE I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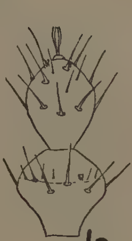
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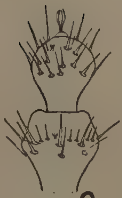
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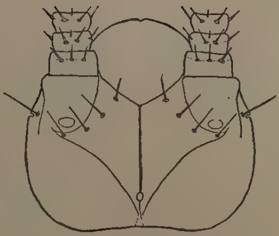
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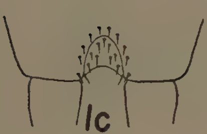
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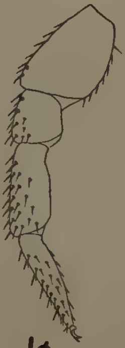
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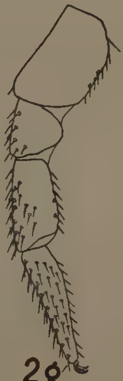
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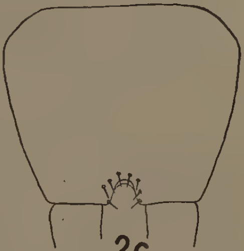
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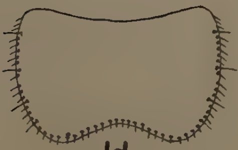
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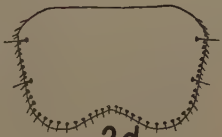
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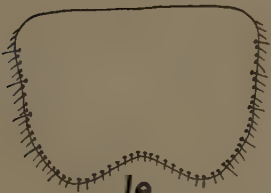
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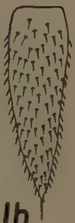
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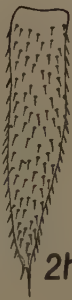
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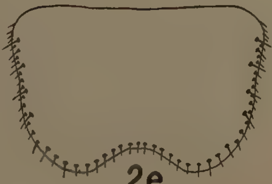
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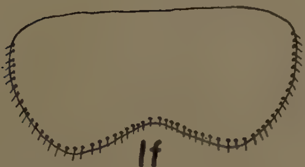
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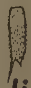
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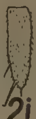
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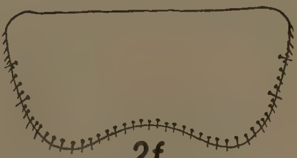
2f

lateral setae. In case of the third scutum the longest lateral setae only about two and one-half times the length of the shortest marginal setae, and in case of the fourth scutum only about twice as long. Setae of fifteenth scutum not carried into the cavity. *Trochanter* of last pair of legs without setae on posterior surface, one or two on outer surface, several on inner surface and entire anterior surface sparsely covered; *femur* with several setae on posterior surface, seven or eight on outer surface, some on inner surface, and seven or eight sparsely scattered setae on anterior surface. *Tibia* with about eight setae on posterior surface about 14 arranged in two rows on outer surface, a number on inner surface, and anterior surface well covered with setae; *Tarsus* with posterior surface well covered, outer surface with about 18 setae arranged in two rows, a row of setae on inner surface and a rather large number on the anterior surface, the most of which are very short; tarsus at least three and one-half times as long as wide; anterior *claw* somewhat more robust than posterior one, but not so strongly curved. Inner surface of trochanter of second pair of legs armed with two long setae the longest of which is more than one-half the width of the segment. *Styli* well developed; about three times as long as their grestest width, covered with numerous short hairs; armed at apical end with one short and one well developed seta; below the large seta and about two-thirds from base of stylus there is another well developed although smaller seta. *Calicles* from which posterior sensory setae (trichobothria) arise surrounded by branched setae; on inner margin of ring of branched setae there are two strong spines. *Cerci* about four and two-tenths times as long as their greatest width; rather densely covered with moderately short setae; terminal area small and facing outward. *Length* seven to nine mm.

Holotype No. 5190. Calif. Acad. Sci. Ent., Portici, Italy. Described from nine specimens sent to me by Dr. F. R. Silvestri, under a letter dated December 20, 1933. The species can be separated from other members of the genus except *S. verhoeffi* by the long slender cerci. It may be distinguished from *S. verhoeffi* by the fact that the posterior margin of the second, third, and fourth scuta are deeply emarginate, whereas in *S. verhoeffi* the posterior margins of the three mentioned scuta are only slightly emarginate. *S. silvestri* is the largest species that I have yet encountered. Among the specimens at hand there is a seventh instar individual which is seven and one-half mm. in length. Only one antenna was unbroken and this contained 37 segments, a large number when compared to a similar stage of *S. immaculata* which normally has 24 to 27 antennal segments.

Scutigerella palmonii n. sp.

(Plate II, figs. 1a to 1i)

Head slightly longer than wide, central rod (coronal suture) complete in its entire length, although less distinct in its anterior portion; lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present. Long seta located between post-antennal organ and spiracle only about as long as the greatest width of third antennal segment. Top of head set with setae of several lengths; between lateral branches and side of head there are a number of long setae, the longest about three times the length of the shortest found in the same general area.

Antennae broken on most specimens; where complete the number of segments ranged from 32 to 36. Second antennal segment with three setae on dorsal surface, of which the outer one is thicker and more strongly developed. Outer setae on other basal segments larger than those on inner surface; on dorsal surface of third antennal segment just anterior to primary row of setae and in medial position there is a strong short spine; second whorl of setae starts on sixth to ninth segment. Apical segment with large stalked organ set on prominent base; one or two smaller sensory organs also present; organs similar to the latter may be found on dorsal surface and to the outside on all segments from sixth or seventh to apical segment.

Second *scutum* with from 36 to 44 marginal and sub-marginal setae of several lengths and with posterior margin moderately emarginate, third scutum with from 45 to 57 marginal and sub-marginal setae of several lengths and with posterior margin emarginate; fourth scutum with from 45 to 55 marginal and sub-marginal setae of several lengths and with posterior margin emarginate. On all three scuta the longest lateral setae tend to be sub-marginal as compared to the shorter setae. Longest lateral setae on fourth scutum hardly one-half the greatest width of third antennal segment. Cavity of fifteenth scutum "V" shaped and setae not carried into it. *Trochanter* of last pair of legs without setae on posterior surface, anterior surface set with rather short setae, outer surface with two or three setae near distal end, and inner surface with a row of setae.

Femur with one seta on outer distal margin of posterior surface, anterior surface set with about five or six rather small setae, outer surface with several large setae and inner surface devoid of setae. Posterior surface of *tibia* set with several setae on outer half, anterior surface sparsely set with rather small setae, outer surface clothed with well-developed setae, one row of which stands rather erect, the inner surface set with a row of rather small setae. Posterior surface of *tarsus* set with setae on outer two-thirds, anterior surface sparsely set with small setae, outer surface with a row of setae that stand rather erect, and inner surface with a row of rather short setae. Tarsus a little more than three and one-half times as long as its greatest width. Anterior *claw* somewhat more robust than posterior one but not so strongly curved. *Styli* well developed not quite four times as long as wide, covered with numerous short hairs, armed at apical end with one short and one well developed seta, no other seta present. *Calicles* from which long posterior sensory setae (trichobothria) arise surrounded with branched setae. *Cerci* about three and six-tenths times as long as their greatest width, well covered with setae, and with terminal area small and facing outward. *Coxal sacs* located at bases of third to tenth pair of legs inclusive. *Length* 4.1 to 5.4 mm.

Holotype No. 5191. Calif. Acad. Sci. Ent., Palestine. Described from eleven adult specimens sent me by Mr. J. Palmoni under a letter dated May 27, 1940. The specimens were collected on the eastern bank of the River Jordan, near its emergence from the Lake of Galilee, at an elevation of about 200 meters below sea level. This species is most closely related to *S. nodicercus*, but the cerci lack the slight expansion of the terminal area, and are more densely clothed with setae. Further, the cavity of the fifteenth scutum is "V" shaped, while in *S. nodicercus* it is "U" shaped.

Scutigerella nodicercus n. sp.

(Plate II, figs. 2a to 2i)

Head slightly longer than wide, central rod (coronal suture) complete in its entire length, although less distinct in its anterior portion; lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present. Long seta located between post-antennal organ and spiracle about as long as the greatest width of the third antennal segment. The two long setae located nearest post-antennal organ on sclerite defined by the lateral and frontal sutures, posterior to post-antennal organ and nearly in line with the horizontal axis of the head. Top of head set with setae of several lengths, between lateral branches and side of head there are a number of long setae; the longest about three times the length of the shortest found in same general area. Number of *antennal* segments ranging from 27 to 38.

Second antennal segment with three setae on dorsal surface, of which the outer one is thicker and more strongly developed. Outer setae on other basal segments larger than those on inner surface; on dorsal surface of third antennal segment just anterior to primary row of setae and in medial position there is a strong short spine; second whorl of setae starts on sixth or seventh segment. Apical segment with large stalked organ set on prominent base; a smaller sensory organ also present, organs similar to latter may be found on dorsal surface and to the out-

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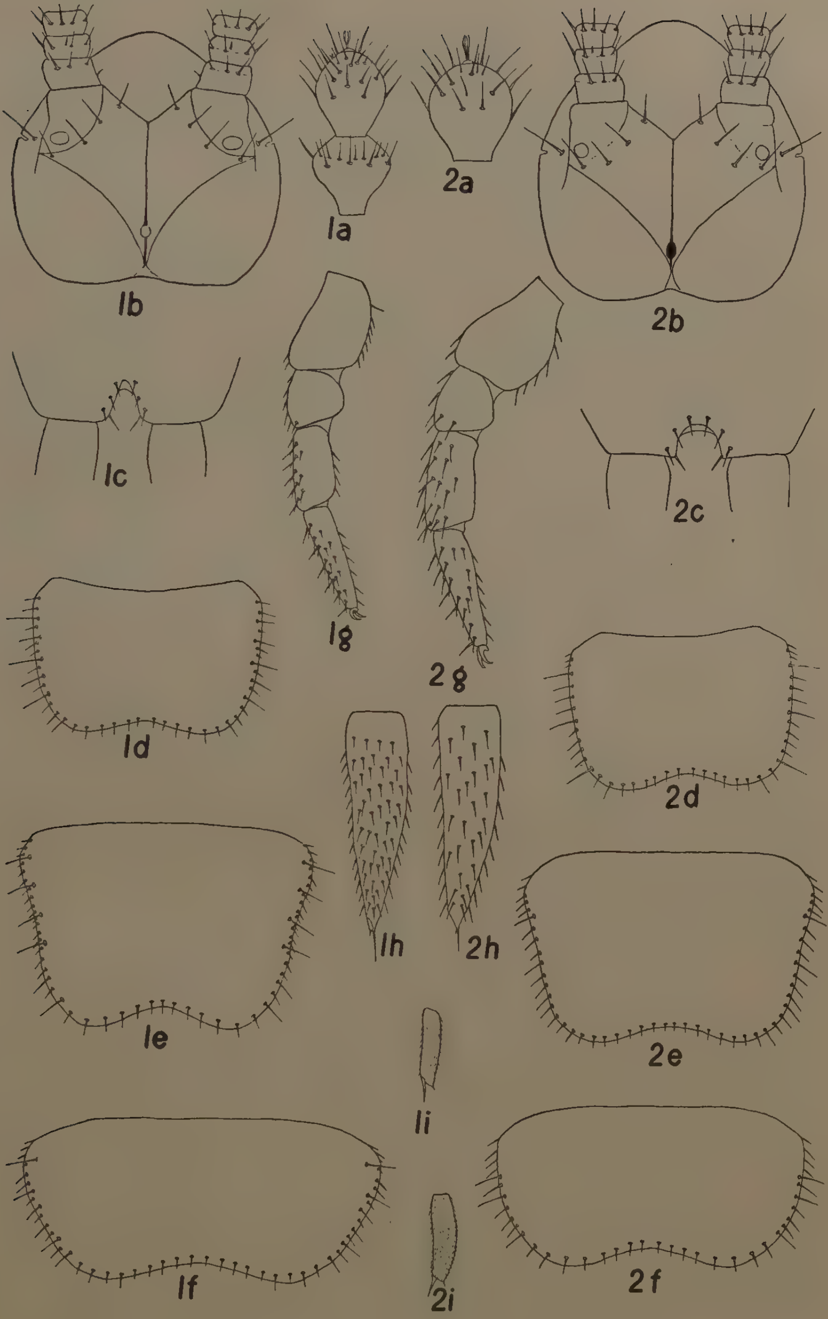
EXPLANATION OF PLATE II

Fig. 1. *Scutigerella palmonii* n. sp. 1a, dorsal view of last two segments of antenna; 1b, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 1c, cavity associated with fifteenth scutum, only the setae in or close to the cavity are drawn; 1d to 1f, second, third and fourth scuta, only marginal setae and the longer sub-marginal setae are shown; 1g, posterior view of twelfth leg; 1h, cercus; 1i, stylus. (All × 80 except 1a and 1i, × 160.)

Fig. 2. *Scutigerella nodicercus* n. sp. 2a, dorsal view of last antennal segment; 2b, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 2c, cavity associated with fifteenth scutum, only setae in or close to the cavity are drawn; 2d to 2f, second, third, and fourth scuta, only marginal setae and the longer sub-marginal setae are shown; 2g, posterior view of twelfth leg; 2h, cercus; 2i, stylus. (All × 80 except 2a and 2i, × 160.)


1a
2a
1b
2b
1c
1g
2g
2c
1d
2d
1h
2h
1e
2e
1i
1f
2i
2f

side on all segments from the seventh or eighth to apical segment. Second scutum with from 32 to 44 marginal and sub-marginal setae of several lengths and with posterior margin only moderately emarginate; third scutum with 36 to 48 marginal and sub-marginal setae of several lengths and with the posterior margin moderately emarginate; fourth scutum with 38 to 40 marginal and sub-marginal setae of several lengths and with posterior margin moderately emarginate. On all three scuta the longest lateral setae tend to be sub-marginal as compared to the shorter setae. Longest lateral setae on fourth scutum only a little more than one-half the greatest width of the third antennal segment. Cavity of fifteenth scutum "U" shaped and setae not carried into it.

Trochanter of last pair of legs without setae on posterior surface, anterior surface set with rather short setae, outer surface with two or three setae near distal end, and inner surface with a row of setae. *Femur* with about two setae on outer distal margin of posterior surface, anterior surface set with about five rather small setae, outer surface with several large setae and inner surface devoid of setae. Posterior surface of tibia set with numerous setae on outer half, anterior surface sparsely set with small setae, outer surface clothed with well developed setae, and none found on inner surface. Posterior surface of *tarsus* set with setae, anterior surface covered with short setae; outer surface with a row of setae that stand rather erect, and inner surface with a row of short setae. Tarsus about three and one-half times as long as its greatest width. Anterior claw somewhat more robust than posterior one but not so strongly curved. *Styli* well developed about three and one-half times as long as their greatest width covered with numerous short hairs, armed at apical end with one short and one well developed seta, no other seta present. *Calicles* from which the long posterior sensory setae (trichobothria) arise surrounded with branched setae. *Cerci* about three and six-tenths times as long as their greatest width, well covered with moderately large setae; those at apical end slightly longer than those at base, terminal area small and faces outward, slightly expanded. *Coxal sacs* located at bases of third to tenth pair of legs inclusive. *Length* 4.7 to 6.1 mm.

Holotype No. 5192. Calif. Acad. Sci. Ent., Salsburg, Germany. Described from seven specimens sent by Dr. K. W. Verhoeff from Salsburg and Oberbayern, Germany, with a letter dated April 14, 1938. The specimens from Oberbayern were collected at an elevation of 1000 to 1450 meters. This species is most closely related to *S. palmonii* and the characters which separate them are considered under the latter species. It is also closely related to *S. inculta* but on the fourth scutum there is no long lateral seta such as is found in the latter. The slight expansion of the terminal area of the cerci is also a difference worthy of note. The cavity of the fifteenth scutum is "U" shaped whereas in *S. inculta* it is more "V" shaped. Finally, there is no lateral seta on the styli such as found in *S. inculta*.

Scutigerella verhoeffi n. sp.

(Plate III, figs. 1a to 1i)

Head about as wide as long, central rod (coronal suture) complete in its entire length, although slightly less distinct in its anterior portion; lateral branches arise near base of head and continue diagonally to a point just posterior and to the side of the post-antennal organs; anterior branches (frontal sutures) present. Long seta located between post-antennal organ and spiracle considerably longer than the width of the third antennal segment. Top of head set with setae of several lengths; between lateral branches and side of head there are a number of long setae, the longest about four times the length of shortest setae found in the same area. Number of *antennal* segments ranged from 39 to 53. Second antennal segment with three setae on dorsal surface of which the outer one is thicker and more developed; outer setae on other basal segments larger than those on inner surface; on dorsal surface of third antennal segment just anterior to primary row of setae and in medial position there is a strong short spine; second whorl of setae starts on eighth to thirteenth segment; apical segment with large stalked organ set on prominent base; one or two small sensory organs also present; organs similar to latter may be found on dorsal surface and to the outside on all segments from seventh or eighth to apical segment.

The second *scutum* with from 47 to 55 marginal and sub-marginal setae of several lengths and with the posterior margin only slightly emarginate; third scutum with from 58 to 73 marginal and sub-marginal setae of several lengths and with the posterior margin slightly emarginate; fourth scutum with 56 to 72 marginal and sub-marginal setae of several lengths and with hind margin slightly emarginate. On all three scuta the longest lateral setae are sub-marginal as compared to shorter setae. Cavity of fifteenth scutum "V" shaped and in only one out of four specimens were setae carried into it. *Trochanter* of last pair of legs without any setae on posterior surface, anterior surface set with setae, outer surface with two or three setae near the posterior end, and inner surface with a row of setae. *Femur* with three or four setae on outer distal margin of posterior surface, anterior surface set with seven or eight setae, outer surface with setae, and none on inner surface. Posterior surface of *tibia* set with setae on outer half, entire anterior surface set with setae, as is outer surface, and none on inner surface. Posterior surface of *tarsus* with setae on outer two-thirds, anterior surface set with rather short setae, outer surface set with large setae, and inner surface set with setae that are shorter than those on outer surface. Tarsus about four times as long as its greatest width. Anterior *claw* somewhat more robust than posterior one but not so strongly curved. *Styli* well developed about four times as long as their greatest width, covered with numerous short hairs, armed at apical end with one short and one well developed seta, no other setae present. *Calicles* from which the long posterior sensory setae (trichobothria) arise surrounded with branched setae. *Cerci* about four times as long as their greatest width, well covered with moderately short setae, terminal area small and facing outward. *Coxal sacs* located at bases of third to eleventh pair of legs inclusive. Thus there are nine pairs instead of the usual eight pairs. *Length* 4.9 to 7.8 mm.

Holotype No. 5196. Calif. Acad. Sci. Ent., probably from the Austrian Alps in southern Germany. Four specimens were sent me by K. W. Verhoeff with a letter dated April 14, 1938. The label on the vial is poorly written, but examples are presumably from the locality above mentioned. This species is most closely related to *S. causeyae* but it is larger, more marginal and sub-marginal setae are found on the scuta, and the cerci are about four times as long as their greatest width (in *S. causeyae* they are only about three and four-tenths times as long as wide). In addition, the cavity of the fifteenth scutum is "V" shaped while in *S. causeyae* it is more "U" shaped. Finally, there are nine pairs of coxal sacs which is a very distinctive feature.

Scutigerella causeyae n. sp.

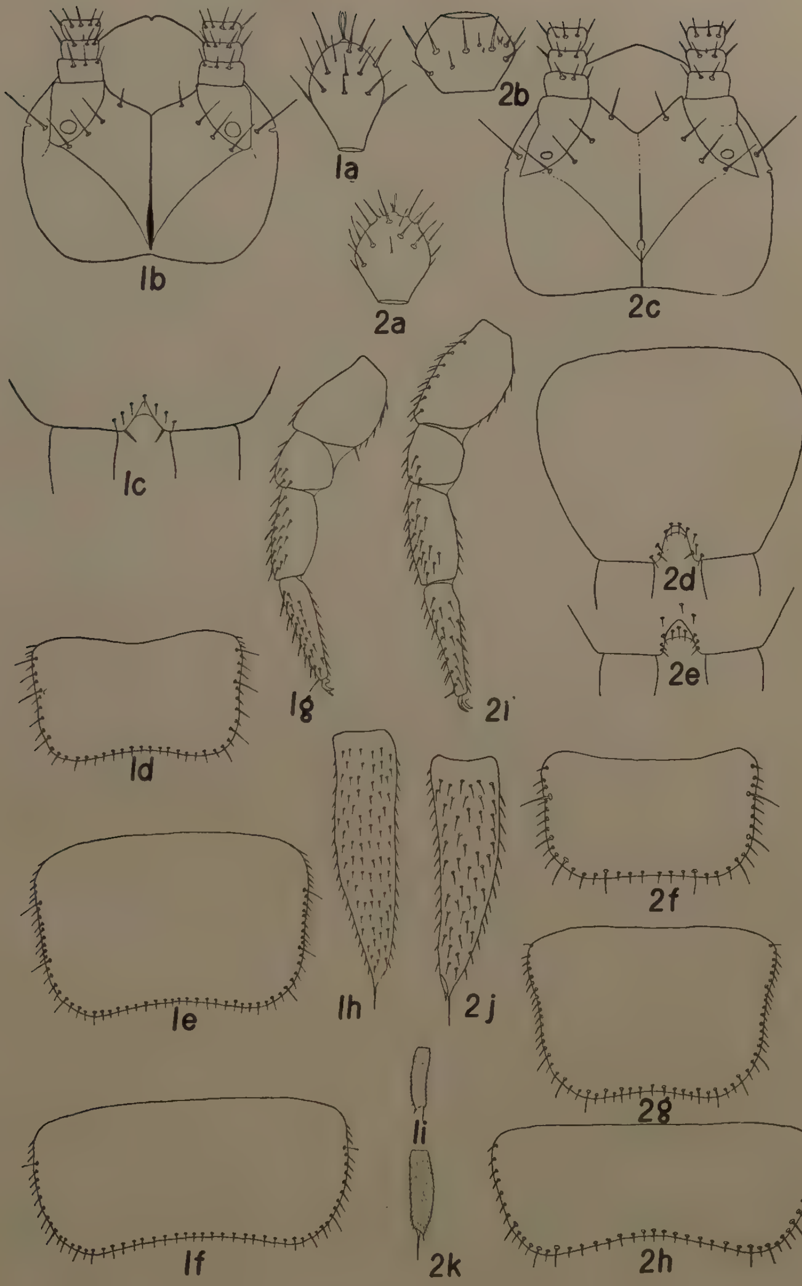
(Plate III, figs. 2a to 2k)

Head about as wide as long, central rod (coronal suture) complete in its entire length, although less distinct in its anterior portion, lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present; long seta located between post-antennal organ and spiracle at least one and three-tenths times longer than the width of the third antennal segment. Top of head set with setae of several lengths; between the lateral branches and side of head there are several long setae; longest are only about two times the length of the shortest setae found in same general area. *Antennae* in most specimens broken or appeared to have been regenerated, number of segments in individuals with normal appearing antennae ranged from 29 to 38. Second antennal segment with three setae on dorsal surface of which the outer one is the largest; outer setae on other basal segments considerably thicker than those on inner side. On dorsal surface of third antennal segment just anterior to primary row of setae and in medial position there is a strong short spine; second whorl of setae starts at about the seventh segment. Apical segment with large stalked organ set on prominent base; one or two smaller sensory organs also present.

EXPLANATION OF PLATE III

Fig. 1. *Scutigerella verhoeffi* n. sp. 1a, dorsal view of last antennal segment; 1b, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 1c, cavity associated with fifteenth scutum, only the setae in or close to the cavity are shown; 1d to 1f, second, third, and fourth scuta, only marginal and the longer sub-marginal setae are shown; 1g, posterior view of twelfth leg; 1h, cercus; 1i, stylus. (All × 64 except 1a, × 128 and 1i × 85.)

Fig. 2. *Scutigerella causeyae* n. sp. 2a, dorsal view of last antennal segment; 2b, dorsal view of twelfth antennal segment; 2c, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 2d and 2e, cavity associated with fifteenth scutum, only the setae in or close to the cavity are shown; 2f to 2h, second, third, and fourth scuta, only marginal and the longer sub-marginal setae are shown; 2i, posterior view of twelfth leg; 2j, cercus; 2k, stylus. (All × 85 except 2a, 2b, and 2k, × 170.)


1a
2b
1b
2a
2c
1c
2d
2e
1d
1g
2i
1h
2j
2f
1e
2g
1i
1f
2k
2h

Organs similar to the latter found on dorsal surface and to the outside on all segments from the fifth, sixth, or seventh to apical segment.

Second *scutum* with from 38 to 44 marginal and sub-marginal setae of several lengths and with the posterior margin truncate or barely emarginate; third scutum with from 54 to 57 marginal and sub-marginal setae of several lengths and with posterior margin only slightly emarginate; fourth scutum with 48 to 50 marginal and sub-marginal setae of several lengths and with the posterior margin distinctly emarginate. On all three scuta the longest setae tend to be sub-marginal as compared to the shorter setae; longest setae of second scutum slightly more than twice the length of the shortest; in case of third and fourth scuta the longest setae only about twice the length of the shortest; both third and fourth scuta devoid of any very long setae. Setae of fifteenth scutum rarely carried into cavity. *Trochanter* of last pair of legs without any setae on posterior surface, anterior surface sparsely set with setae, outer surface well armed with setae, and at least a row of setae on inner surface. *Femur* with two or three setae on posterior surface, three or four on anterior surface, well clothed on outer surface and none on inner surface. *Tibia* well clothed with setae on outer half of posterior surface, sparsely set with relatively short setae on anterior surface, well clothed on outer surface, and with a row of four or five setae on inner surface; *tarsus* well armed with setae on posterior surface, anterior surface sparsely clothed with relatively short setae, outer surface with a row of eight or nine setae and inner surface with a row of setae; tarsus about four times as long as its greatest width.

Anterior *claw* somewhat more robust than posterior one but not so strongly curved. Inner surface of trochanter of second pair of legs armed with several large setae whose length is considerably more than one-half the width of the segment, *Styli* well developed, about three and one-half times as long as their greatest width, covered with numerous short hairs; armed at apical end with one short and one well developed seta, no other seta present. *Coxal sacs* located at bases of third to tenth pair of legs inclusive. *Calicles* from which the posterior sensory setae (trichobothria) arise surrounded with branched setae. *Cerci* about three and four-tenths times as long as their greatest width; rather densely clothed with moderately short setae; terminal area small and facing outward. Length 4.3 to 5.2 mm.

Holotype No. 5193. Calif. Acad. Sci. Ent., Durham, North Carolina, May, 1940. Described from eighteen specimens sent me by Dr. N. B. Causey. With the exception of *S. verhoeffi* this species is easily distinguished from other members of the genus by the shape of the scuta, and by the very slight emargination of their posterior margins. The number of marginal and sub-marginal setae on the second, third, and fourth scuta are less than found in *S. silvestri* and *S. immaculata* but more than found in *S. inculta* and *S. linsleyi*. The length of the setae on these scuta is relatively shorter than those found in the latter two species. Characters that distinguish it from *S. verhoeffi* are considered under the latter species. It might be added that the posterior margin of the second scutum is truncate, whereas in *S. verhoeffi* it is barely emarginate.

Although the largest number of antennal segments represented in the series is 38, the highest possible number probably considerably exceeds this. This opinion is based on the fact that in the material in my possession there are a sixth and a seventh instar individual each with its antennae complete. The sixth instar specimen has 24 and 25 segments in the antennae while the seventh instar individual has 27 segments. For the same stage individuals in *S. immaculata* the range for the respective stages is 20 to 24 and 24 to 27 (Michelbacher, 1938). Old specimens of *S. immaculata* may finally develop as many as 60 segments in the antennae. Because of the similar number of segments found in the younger instars of the two species it is reasonable to believe that old individuals of *S. causeyae* would probably develop approximately as many segments as found in *S. immaculata*.

Apparently *S. causeyae* is a species that occurs in uncultivated areas. All the specimens sent me were collected in forested regions.

Scutigerella linsleyi n. sp.

(Plate IV, figs. 1a to 1i)

Head slightly longer than wide, central rod (coronal suture) complete in its entire length; lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present. Long setae located between post-antennal organ and spiracle slightly shorter than width of third antennal segment. Left *antenna* of type broken, right of 23 segments. Dorsal surface of second segment with three setae of which the outer one is much the larger; second whorl of setae begins at about the seventh segment. Apical segment with large stalked organ, and either one or two other very small sensory organs. Other sensory organs similar to the latter are found in the type on all segments from the seventh on with the exception of the eighteenth which has none. Their location is dorsal and to the outside of the segment and almost in line with row of primary setae. In the species there is some variation in the number of segments that carry these sensory organs.

The second *scutum* with from 33 to 36 marginal and sub-marginal setae of several lengths; the longest are found along the lateral edges, and are about twice the length of shortest setae; hind margin of scutum deeply emarginate. Third scutum with from about 40 to 44 marginal and sub-marginal setae of several lengths and with the hind margin deeply emarginate. Fourth scutum with from 37 to 42 marginal and sub-marginal setae of several lengths, the longest of these about twice the length of the shortest, hind margin of scutum strongly emarginate. Setae of fifteenth scutum not carried into cavity. *Trochanter* of last pair of legs without setae on posterior surface, anterior surface sparsely set with setae, outer surface with setae at distal end and inner surface with a row of several setae; *Femur* with one or two setae on outer edge of posterior surface, three or four setae on anterior surface, about four arranged in two rows on outer surface and none on inner surface; *Tibia* with about six setae on the outer posterior surface, anterior surface very sparsely set with smaller setae, a row of four on outer surface and none on inner surface; *Tarsus* with about seven setae on posterior surface, anterior surface sparsely set with very small setae, a row of three or four setae on the outer surface, and about two setae on inner surface; *Tarsus* about three and one-half times as long as its greatest width. Anterior *claw* slightly more robust than the posterior one but not quite so strongly curved. The inner side of trochanter of the second pair of legs armed with several large setae, the largest of which is one-half the greatest width of the segment. *Styli* well developed, about three times as long as wide, covered with numerous short hairs armed at apical end with one short and one long well developed seta. *Coxal sacs* located at bases of third to tenth pair of legs inclusive. *Calicles* from which the posterior sensory setae (trichobothria) arise surrounded by branched setae. *Cerci* about three and two-tenths times as long as their greatest width; covered with rather long sparsely set setae; terminal area small and facing outward. *Length* three and one-half to four mm.

Holotype No. 5194. Calif. Acad. Sci. Ent., Idyllwild, California, April 11, 1939. Described from seven specimens collected in a loamy soil on a slope covered with rather dense growing brush. The species was taken at an elevation of about a mile and thus far no specimens have been found in any other locality. *S. linsleyi* can be separated from other members of the genus by its small size and fewer setae on the tarsus and cerci. The scuta are very deeply emarginate, their shape is different than that of other species, and they bear relatively fewer marginal and sub-marginal setae. A very distinctive character is the

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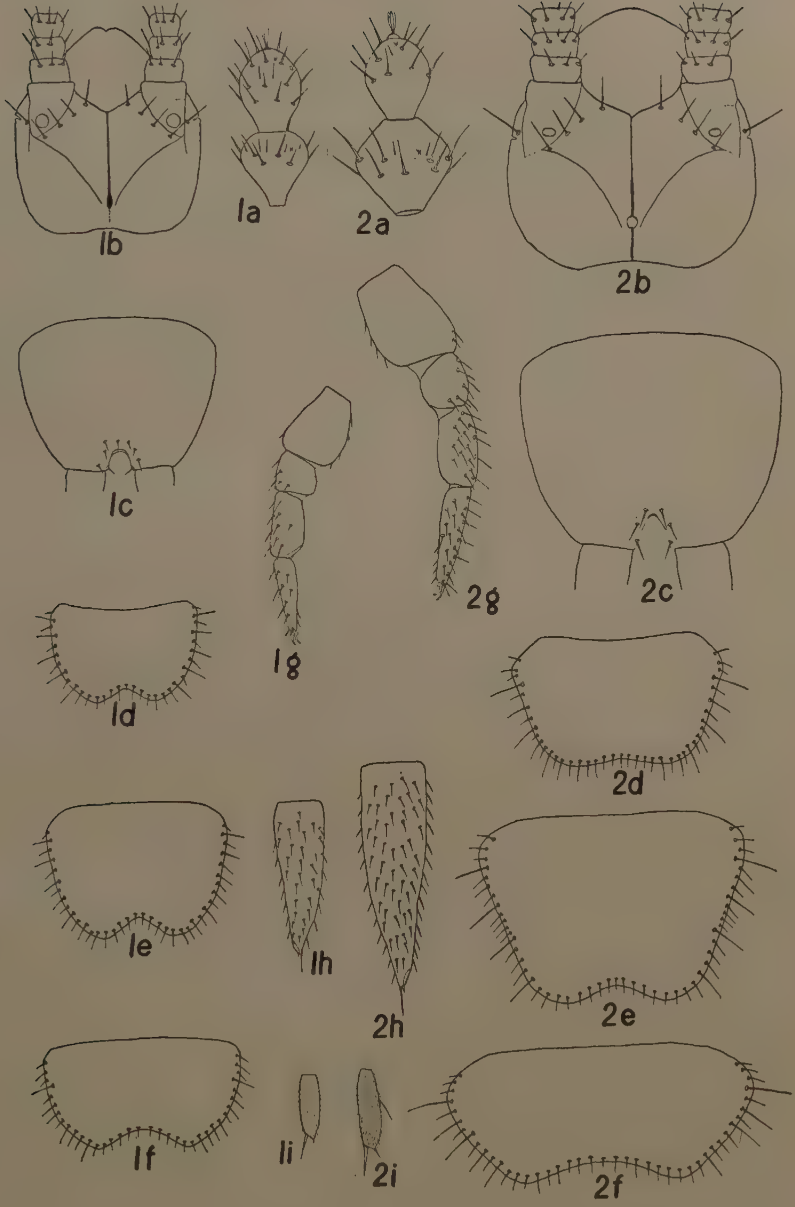
EXPLANATION OF PLATE IV

Fig. 1. *Scutigerella linsleyi* n. sp. 1a, dorsal view of last two antennal segments; 1b, head and first four antennal segments, only the long setae on anterior half of head and those of the antennal segments are shown; 1c, cavity associated with fifteenth scutum, only setae in or close to the cavity are shown; 1d to 1f, second, third, and fourth scuta, only marginal and the longer sub-marginal setae are shown; 1g, posterior view of twelfth leg; 1h, cercus; 1i, stylus. (All × 85 except 1a and 1i, × 170.)

Fig. 2. *Scutigerella inculta* n. sp. 2a, dorsal view of last two antennal segments; 2b, head and first four antennal segments, only the long setae on the anterior half of head and those of the antennal segments are shown; 2c, cavity associated with the fifteenth scutum, only setae in or close to the cavity are shown; 2d to 2f, second, third, and fourth scuta, only marginal and the longer sub-marginal setae are shown; 2g, posterior view twelfth leg; 2h, cercus; 2i, stylus. (All × 85 except 2a and 2i, × 170.)


1b
1a
2a
2b
1c
2g
2c
1g
1d
2d
1e
1h
2h
2e
1f
1i
2i
2f

relatively few antennal segments. None of the specimens had more than 23 segments even though the fourteenth scutum was completely differentiated.

Scutigerella inculta n. sp.

(Plate IV, figs. 2a to 2i)

Head nearly as wide as long, central rod (coronal suture) complete in its entire length, although less distinct in its anterior portion; lateral branches arise near base of head and continue diagonally to a point just posterior and to the outside of the post-antennal organs; anterior branches (frontal sutures) present. Long seta located between post-antennal organ and spiracle at least as long or considerably longer than the greatest width of the third antennal segment. Top of head set with setae of several lengths; between lateral branches and side of head there are a number of long setae, the longest about three times the length of shortest setae found in same general area. Number of *antennal segments* in large specimens ranged from 27 to 34. Second antennal segment with three setae on dorsal surface of which the outer one is the most developed. Outer setae on other basal segments just slightly more developed than those on inner side. On dorsal surface of third antennal segment just anterior to primary row of setae and in medial position there is a strong short spine; second whorl of setae starts on seventh or eighth segment. Apical segment with large stalked organ set on prominent base; a smaller sensory organ also present. Organs similar to the latter may be found on dorsal surface and to the outside on all segments from sixth or seventh to apical segment.

Second *scutum* with 33 to 42 marginal and sub-marginal setae of several lengths, and with posterior margin only slightly emarginate; third scutum with 41 to 47 marginal and sub-marginal setae of several lengths, and with posterior margin rather deeply emarginate; fourth scutum with 39 to 43 marginal and sub-marginal setae of several lengths and with posterior margin distinctly emarginate. There is a very long lateral seta which is considerably longer than width of third antennal segment. On all three scuta the longest lateral setae tend to be slightly sub-marginal as compared to the shorter setae; longest of these setae on second scutum about three times the length of shortest setae; in third scutum longest lateral setae at least three times length of shortest marginal setae; and in fourth scutum about three times as long. Long lateral setae are also found on scuta five to ten inclusive. Setae of fifteenth scutum not carried into cavity. *Trochanter* of last pair of legs without setae on posterior surface, anterior surface sparsely set with setae, outer surface with two or three setae near posterior end, and inner surface with a row of setae; *Femur* with one or two setae on posterior surface, about five on anterior surface, outer surface with five or six setae arranged in two rows and none on inner surface; *Tibia* with about ten setae on posterior surface, about six sparsely set setae on the distal two-thirds of anterior surface, three rows of setae on outer surface of which setae of center row are larger and more erect, and no setae on inner surface; posterior surface of *tarsus* sparsely set with setae, anterior surface on distal two-thirds sparsely set with smaller setae, outer surface with a row of erect setae; these are slightly more erect than the row found on outer surface of tibia; inner surface with a row of setae on distal half. Tarsus nearly four times as long as its greatest width.

Anterior *claw* somewhat more robust than posterior one but not so strongly curved. Inner surface of trochanter of second pair of legs armed with several large setae, whose length is about one-half the width of the segment. *Styli* well developed, about three times as long as their greatest width, covered with numerous short hairs, armed at apical end with one short and one well developed seta. Below small seta and about half way up from base of stylus there is a well developed seta, which is somewhat smaller than large apical seta. This seta is lacking on more anterior styli, and occasionally is not to be found on some of the more posterior ones. *Calicles* from which the posterior sensory setae (trichobothria) arise surrounded with branched setae. *Cerci* about three and two-tenths times as long as their greatest width, well covered with moderately short setae, the terminal area small and facing outward. *Coxal sacs* located at bases of third to tenth pair of legs inclusive. *Length* four and two-tenths to five and five-tenths mm.

Holotype No. 5195. Calif. Acad. Sci. Ent. Calveras Dam, Alameda County, California, April 27, 1939. Described from numerous specimens collected on a hillside covered with a growth of native shrubs and trees. Specimens have also been taken at Woodacre in Marin County and on tree covered hills near Lagunitas. Specimens were found rather abundant in the soil a few inches below the leaf mold. The species has also been taken in the hills back of Vichy Springs in Napa County. It is apparently widely distributed in the uncultivated region surrounding the San Francisco Bay. It appears to prefer tree covered slopes and up to the present time it has never been taken in a cultivated region.

Scutigerella inculta is very distinctive. The long lateral setae of the fourth scutum distinguishes it from all the other known members of the genus. It has relatively long setae on the scuta as compared to other species, and has relatively few marginal and sub-marginal setae on the scuta, a character similar to that found in *S. linsleyi*. The erect setae on the outer surface of the tibia and tarsus are also characteristic, although a similar condition is found in *S. immaculata*, *S. palmonii* and *S. nodicercus*. *S. inculta* is closely related to *S. nodicercus* and the most important characters for the separation of the two are given under the description of the latter species.

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THE AMERICAN COMMISSION ON SCIENTIFIC NOMENCLATURE IN ENTOMOLOGY

The disturbed condition of the world during the last few years has interfered with the activities of the International Commission on Zoological Nomenclature and there is no prospect that this Commission will again function successfully for several years to come. Entomologists in the United States have felt that this situation should not be allowed entirely to stifle progress in the development of nomenclature and the clarification of nomenclatorial problems. At the meetings of the Entomological Society of America and the American Association of Economic Entomologists in San Francisco, in December, 1941, a plan was adopted which called for the establishment of an American Commission on Scientific Nomenclature in Entomology.

In accord with the terms of this plan, Mr. C. F. W. Muesebeck and Professor G. F. Ferris were appointed to organize the Commission. That organization has now been completed and the Commission is ready to function. It includes Prof. J. C. Bradley, of Cornell University; Mr. W. J. Brown and Mr. G. Stuart Walley, of the Division of Entomology of the Department of Agriculture of Canada; Prof. G. F. Ferris, of Stanford University; Prof. T. H. Hubbell, of the University of Florida; Prof. H. B. Hungerford, of the University of Kansas; Dr. E. G. Linsley, of the University of California; Prof. Clarence E. Mickel, of the University of Minnesota; Mr. C. F. W. Muesebeck and Mr. P. W. Oman, of the United States Bureau of Entomology and Plant Quarantine; Prof. A. G. Richards, Jr., of the University of Pennsylvania; Dr. Herbert H. Ross, of the State Natural History Survey of Illinois; Prof. C. W. Sabrosky, of the State Agricultural College of Michigan; Dr. R. L. Usinger, of the College of Agriculture of California. Prof. G. F. Ferris has been elected as Chairman.

The Commission will receive, consider and advise upon such nomenclatorial problems as are presented to it. All acts of the Commission will be in harmony with the International Rules of Zoological Nomenclature, although recommendations for the clarification, extension and improvement of these rules may be made. The Commission will report to the two parent societies at their next annual meeting. Communications concerning matters within the province of the Commission may be addressed to any of its members.—E. N. C.

NOTES ON TABANIDAE (DIPT.) FROM PANAMA

IX. THE GENERA STENOTABANUS LUTZ, LEPISELAGA MACQUART AND RELATED GENERA[1, 2]

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The group here treated includes five genera. Of these, *Stenotabanus*, *Lepiselaga* and *Diachlorus* appear to form a more or less related group. Such forms as *Diachlorus paradoxus* Lutz show many characters linking it with *Lepiselaga*, while *Stenotabanus calvitius* n. sp. is also quite *Lepiselaga*-like in a number of ways. *Selasoma* is much like a giant *Lepiselaga*, but there are a number of rather fundamental characters separating them, while *Bolbodimyia* still appears to have no close relatives.

Genus **Selasoma** Macquart

1838, Dipt. Exot., I, part 2, p. 187 (Type *Tabanus tibialis* Fab.). Surcouf, 1921, Gen. Insect., Fasc. 175, Dipt., Taban., p. 45. Lutz, 1913, Mem. Inst. Osw. Cruz, V, 2, p. 178. Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 346; 1925, Op. cit., XI, 2, p. 352. Kröber, 1929, Enc. Ent., Ser. B, II, Dipt., V, pp. 104, 142. Borgmeier, 1933, Rev. Ent., III, p. 301. Kröber, 1934, Rev. Ent., IV, 2, p. 253.

Three species are placed by Kröber (1934) in this genus, *tibiale* Fab., *giganteum* Lutz and *nigrocaeruleum* Rond. Of these, *giganteum* seems only known from the types, which had no third antennal segment, and the species has not been subsequently recognized. *Nigrocaeruleum* has also not been taken since described, while the original description states that the antennae have a long dorsal spine. I suspect, therefore, that the species is very doubtfully assignable to *Selasoma*, and is more likely some species of *Dicladocera*, perhaps near *riveti* Surc.

The genus is not very clearly related to any others, but seems nearest *Lepiselaga*.

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[1] Part VI, these Annals, September, 1941, Parts VII and VIII, June, 1942.

[2] Printing costs paid by Gorgas Memorial Institute of Tropical and Preventative Medicine, Inc.

Selasoma tibiale Fabricius

(Figs. 1, 1a, 1b)

Tabanus tibialis Fabricius, 1805, Syst. Antl., p. 102 (no sex; America merid.). Wiedemann, 1821, Dipt. Exot., I, p. 89; 1828, Auss. Zweifl. Insekten, I, p. 164 (♀; South America). Von Röder, 1892, Wien Ent. Zeit., XI, 8, p. 237 (♀; Brazil).

Selasoma tibiale Macquart, 1838, Dipt. Exot., I, 2, p. 188 (♀; au nord de la capitainerie de Goyaz). Walker, 1854, List Dipt. Brit. Mus., Part V, Suppl. 1, p. 273. Kertesz, 1900, Cat. Taban., p. 28. Surcouf and Gonzalez-Rincones, 1912, Dipt. Vuln. Venezuela, II, p. 36. Lutz, 1913, Mem. Inst. Osw. Cruz, V, 2, p. 179, Pl. 13, fig. 21 (♀; Venezuela and Brasilian states of Rio de Janeiro, Sao Paulo, Minas Geraes, Goyaz, Bahia and Ceará). Ricardo, 1904, Ann. Mag. Nat. Hist., XIV, (7), p. 354. Surcouf, 1921, Gen. Insect., Fasc. 175, p. 47, Pl. 2, figs. 10a, 10b (Bresil). Kröber, 1929, Enc. Ent., Ser. B, II, Dipt., V, pp. 104, 142; Pl. 1, fig. 9; Pl. 3, figs. 48, 49, 62, 67; Pl. 4, figs. 94, 96, 97 (♂, ♀; Matto Grosso, Bolivia, Argentina, Brazil); 1934, Rev. Ent., IV, 2, p. 253.

Hadrus chalybaeum Perty, 1833, Del. Anim. art. Brasil, p. 183, Pl. 36, fig. 20 (Brasil).

Hadrus cyaneum Walker, 1848, List Dipt. Brit. Mus., V, Suppl. 1, p. 208.

Tabanus cyaneum Wiedemann, 1828, Auss. Zweifl. Insekt., I, p. 152. Macquart, 1838, Dipt. Exot., I, 2, p. 188. Walker, 1848, List Dipt. Brit. Mus., V, Suppl. 1, p. 273.

The species is easily separated from anything found in Panama by the basally black wings, shiny blue black abdomen, swollen tibiae, and the wide, flattened nearly toothless third antennal segment. The capture of this species here represents a very considerable extension of the known range, but comparison of Brazilian material with my two specimens has not revealed any important differences.

Distribution: Northern Argentina, Bolivia, Brasil, Venezuela and Panama.

Panama records: 2 ♀, Moja Pollo, Chagres River region, Jan. 19 and 31, 1940.

Genus **Lepiselaga** Macquart

1838, Dipt. Exot., I, 1, p. 153. Bequaert, 1924, Psyche, XXXI, 1, p. 26. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 342. Borgmeier, 1933, Rev. Ent., IV, 2, p. 252. (Type, *Haematopota crassipes* Fab., 1805.)

Hadrus Perty, 1833, Del. Anim. Artic. Brasil, p. 183 (not *Hadrus* Dejean, 1833. Coleoptera).

Lepidoselaga Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., II, p. 435. Lutz, 1913, Mem. Inst. Osw. Cruz, V, 2, p. 30 (uses both *Lepiselaga* and *Lepidoselaga*). Krober, 1929, Enc. Ent., Ser. B, II, Diptera, V, p. 136.

But three species of this well marked and strictly Neotropical genus are known, and but one of these, the very widespread *L. crassipes* Fab., occurs in Panama. *Lepiselaga* does not appear to be very closely related to any other *Tabaninae*, but comes nearest *Selasoma*, *Diachlorus* and *Stenotabanus*.

The Genus may be characterized as follows: Small flies, seldom if ever reaching 10 mm. in length. Eyes bare, purplish black with green bands. Frons broad, without ocelli or vertexal tubercle. Frontal callus well developed. Subcallus and facial area shiny and rather protuberant. Antennae with first two segments subcylindrical, the first 2 to 4 times as long as the second, the second about as long as wide. Third segment slender, the basal part subcylindrical or with a weak angle above, the terminal part of 4 annuli, which are sometimes nearly fused. Basal part at least twice length of annulate part. Palpi exceedingly broad and flattened, convex outwardly, flattened or concave inwardly, shiny. Proboscis short, shorter than head height, the labella mostly membranous, but with a small shiny plate near the base, about half length of proboscis. Thorax and abdomen, especially the latter, rather short and stout. Legs short and heavy, all tibiae markedly incrassate. Wings with subepaulet bare, costa, subcosta, and first vein with macrotrichia above, only costa and subcosta spinose beneath. All cells but anal open, no appendix on third vein. Wing black to the apex of discal cell or a little beyond, the apex and a triangular area in the region of the fifth posterior cell hyaline. Male (of *crassipes*) with palpi even larger and shinier than female, fronto-clypeus pollinose, reduced, and sunk between the greatly inflated genae. Eyes holoptic, bare, the large facets not greatly differentiated occupying about two-thirds eye area, and extending to the occipital margin. No tubercle between eyes at vertex.

Lepiselaga crassipes (Fabricius)

(Figs. 2, 2a, 2b)

Haematopota crassipes Fabricius, 1805, Syst. Antl., p. 108 (no sex; South America).

Lepiselaga crassipes J. Bequaert, 1926, Medical Rept. Harvard Exp. Amazon, p. 225 (with full synonymy). Kröber, 1934, Rev. de Entomologia, IV, p. 253. Van Volkenberg, 1939, Puerto Rico Agric. Expt. Sta., Circ. 22, p. 4. Bequaert, 1940, Rev. Ent., XI, 1–2, p. 285 (Cuba, Hispaniola, Puerto Rico); 1938, Carnegie Inst. Washington, Publ. No. 499, p. 226 (Guatemala). Fairchild, 1940, Psyche, XLVII, 1, p. 8, Pl. II, figs. 1–5 (early stages).

Tabanus lepidotus Wiedemann, 1828, Aussereurop. Zweifl. Ins., I, p. 193 (female; Brazil).

Lepiselaga lepidota Jaennicke, 1867, Abh. Senckenberg Naturf. Ges., 6, p. 312. Hine, 1910, Ohio Naturalist, X, 6, p. 149. Lutz, 1928, Est. Zool. Parasit. Venezolanas, pp. 56, 59, Pl. 9, fig. 2. Dunn, 1934, Psyche, XLI, 3, p. 172.

Lepidoselaga lepidota Loew, 1869, Berlin. Ent. Zeitschr., XIII, p. 6. Gowdey, 1926, Dept. Agric. Jamaica, Ent. Bull. 4, pts. 1–2, p. 76. Hine, 1910, Ohio Naturalist, X, 6, p. 149. Lutz, 1928, Ent. Zool. Parasit. Venezolanas, pp. 56, 59, Pl. 9, fig. 2. Dunn, 1934, Psyche, XLI, 3, p. 172.

Lepidoselaga recta Loew, 1869, Berlin. Ent. Zeitschr., XIII, p. 6 (♀; "New Granada" = Colombia).

Lepidoselaga major Szilády, 1926, Biologica Hungarica, I, pt. 7, p. 21 (♂, ♀; Santiago de las Vegas, Cuba).

Lepidoselaga crassipes Dunn, 1929, Am. Journ. Trop. Med., IX, 6, p. 502 (Colombia). Kröber, 1929, Enc. Ent., Ser. B. II, Diptera, V, p. 137, Pl. I, fig. 12; Pl. II, figs. 15, 45; Pl. III, fig. 61.

There seems no point in repeating the numerous references to this species in the literature, which have been adequately listed by Bequaert (1926). Only those subsequent to that date and the essential original citations are here included.

Freshly emerged specimens are striking insects, the frons, thorax, and most of the abdomen being covered with brilliant irridescent golden green scales. The second abdominal tergite is black at the sides, only a broad median triangle bearing the green scales. In the male, these scales are much less abundant, nearly lacking on thorax and base of abdomen. The species is fairly abundant in Panama, but seldom sufficiently so to be very annoying. I am informed that it was much more plentiful formerly, and the reduction in numbers may be due to the great reduction in the water lettuce (*Pistia stratiotes*) in Gatun Lake which has taken place for unknown reasons in recent years, as that plant appears to be the favored larval habitat.

Distribution: Practically the whole Neotropical region, from Cuba and Southern Mexico to Ecuador, Paraguay and Northern Argentina.

Panama records: Numerous records from the Canal Zone region to Chiriqui in practically all months of the year. No records of the species from Darien Province, though it undoubtedly occurs there.

Genus **Bolbodimyia** Bigot

1892, Wien. Ent. Zeit., XI, p. 162 (Monotypic for *B. bicolor* Big., 1892, Venezuela). Kertész, 1900, Cat. Taban., p. 28. Hine, 1910, Ohio Naturalist, X, 6, p. 150. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 341. Kröber, 1929, Enc. Ent., Ser. B, II, Diptera, V, pp. 109–112 and figs.; 1934, Rev. Ent., IV, 2, p. 257. Stone, 1934, Rev. Ent., IV, 2, p. 190; 1938, U. S. Dept. Agric. Misc. Publ. No. 305, p. 10.

Snowiellus Hine, 1904, Ohio Naturalist, V, 2, p. 230 (Monotypic for *S. atratus* Hine); 1910, Op. cit., X, 6, p. 151, figs. 1 and 5. Williston, 1908, Manual N. Amer. Dipt., p. 181, fig. 65. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 353, (in part).

Five species are included by Kröber (1934) in his catalogue, and Stone (1938) transfers *Snowiellus atratus* Hine, a North American species, to the genus. The Neotropical species seem to be distinguished mainly on the relative amounts of orange and black coloration. I lack material for any definite conclusion, but it seems very possible that most, if not all, of these

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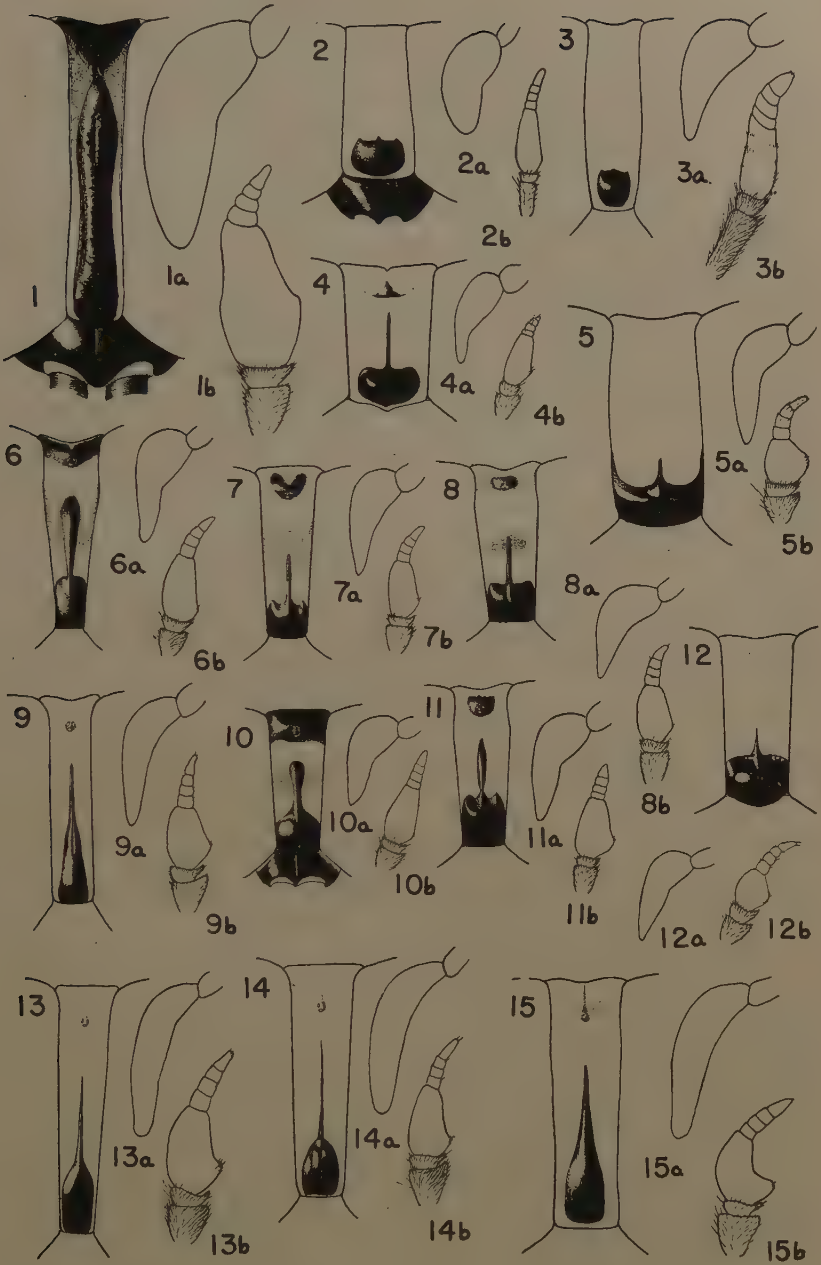
Explanation of Plate I

All figures are of the frons, palpus, and antenna of female specimens, and are all drawn to the same scale. All figured specimens are from Panamá.

Figs. 1, 1a, 1b, *Selasoma tibiale* (Fab.). Figs. 2, 2a, 2b, *Lepiselaga crassipes* (Fab.). Figs. 3, 3a, 3b, *Diachlorus curvipes* (Fab.). Figs. 4, 4a, 4b, *Stenotabanus longipennis* Kröb. Figs. 5, 5a, 5b, *St. changuinolae* sp. nov. Holotype. Figs. 6, 6a, 6b, *St. constabulorum* sp. nov. Holotype. Figs. 7, 7a, 7b, *St. minusculus* (Kröb.). Figs. 8, 8a, 8b, *St. maculifrons* (Hine). Figs. 9, 9a, 9b, *St. jaculator* sp. nov. Holotype. Figs. 10, 10a, 10b, *St. calvitius* sp. nov. Holotype. Figs. 11, 11a, 11b, *St. fulvistriatus* (Hine). Figs. 12, 12a, 12b, *St. paitillensis* sp. nov. Holotype. Figs. 13, 13a, 13b, *St. pequeniensis* sp. nov. Holotype. Figs. 14, 14a, 14b, *St. lerida* sp. nov. Holotype. Figs. 15, 15a, 15b, *St. plenus* (Hine).


1a
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forms are color variants of one and the same species. Six female specimens before me, from Aurá, Pará, Brasil, and Isla de Marajo, Pará, Brasil (R. Damasceno) have the palpi black, the fronto clypeus and genae orange, the thoracic pleura and sternum orange, and a faint orange ventral middorsal stripe on the abdomen. Otherwise the whole insect is black, including the legs. Another specimen, from Restrepo, Dept. Meta, Colombia (J. Bequaert coll.) has only the lower margins of genae and upper half of pleura orange.

The genus, based upon the material cited above, may be defined as follows: Eyes bare, dark purplish black, the lower two-thirds apparently rather finely and irregularly reticulated with green. Frons broad, narrowest at vertex, with basal and median calli, but no vertexal tubercle or vestiges of ocelli. Subcallus greatly inflated, shiny. Face and cheeks pollinose. First antennal segment greatly inflated, either subspherical or only inflated below; second segment short, not inflated, with or without a small dorsal tooth; third segment elongate, slender, the basal part as long or longer than the annulate part, with a dorsal angle very near the base; four annuli present. Palpi moderately slender, shorter than proboscis, the latter shorter than head height, the labium and labella mainly membranous, but with distinct shiny chitinized plates. Fronto-clypeus and genae pollinose, not inflated.

Wings with subepaulet bare, costa and first vein above, and costa and subcosta beneath with macrotrichia. All cells but anal open, no appendix on third vein, but the upper branch turned rather abruptly forward. Wing largely black or smoky. Legs with the tibiae, especially the fore pair, rather inflated. Small species, 12–14 mm. long, generally largely black in color, or with more or less orange or greyish pubescence on sides of body.

Only one species has been reported from Panama, and it is so far known only from the type specimen in the British Museum.

Bolbodimyia erythrocephala (Bigot)

Atylotus erythrocephalus Bigot, 1892, Mem. Soc. Zool. France, V, p. 668 (♀, Panama).
Tabanus erythrocephalus Kertész, 1900, Cat. Taban., p. 49; 1908, Cat. Dipt., III, p. 240. Surcouf, 1921, Gen. Insect., Taban., p. 67.
Bolbodimyia erythrocephala Kröber, 1929, Enc. Ent., Ser. B, II, Diptera, V, p. 112; 1930, Zool. Anzeiger, XC, p. 77, fig. 19 (♀; type); 1934, Rev. Ent. IV, 2, p. 258.

Kröber (1930) has redescribed and figured the type specimen, which has a yellow subcallus and antennae, white beard, and wholly black body with basally white mid and hind tarsi. So far as I know, the species has not since been taken.

Distribution: Panama.

Panama records: Only the original specimen.

Genus **Diachlorus** Osten Sacken

1876, Mem. Boston Soc. Nat. Hist., II, Pt. 4, No. 4, p. 47. Kertész, 1900, Cat. Taban., p. 29. Ricardo, 1904, Ann. Mag. Nat. Hist., (7) XIV, p. 356. Coquillett, 1910, Proc. U. S. Nat. Mus., XXXVII, No. 1719, p. 532 (Type, *Tabanus bicinctus* Fab., 1805). Lutz, 1913, Mem. Inst. Osw. Cruz., V, 2, 144. Surcouf, 1921, Gen. Insect., Taban., p. 49. Bequaert, 1924, Psyche, XXXI, 1, p. 38. Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 349 (Type, *Chrysops ferrugatus* Fab., 1805); 1925, Op. cit., XI, 2, p. 336. Kröber, 1928, Beihefte z. Arch. f. Schiffs-u. Tropen-Hyg., XXXII, Beih. 2, p. 97. Borgmeier, 1933, Rev. Ent., III, 3, p. 290. Kröber, 1934, Rev. Ent., IV, 2, p. 255. Stone, 1938, U. S. Dept. Agric., Misc. Publ. No. 305, p. 13.

Dibasis Macquart, 1834, Hist. Nat. Dipt., V, 1, p. 207. (Type, *Tabanus bicinctus* Fab.). (Not *Diabasis* Hoffmansegg, 1819, Coleoptera.)

According to Kröber's catalogue (1934), this genus contains 23 species and one variety, of which all but three are confined to South America. *D. curvipes* Fab. extends into Central America, while *D. ferrugatus* Fab. ranges from Central America north into the southern United States. *D. badia* Kröb. is described as coming from "Georgia," but Kröber himself expressed skepticism as to the locality label. The same author has listed (1934, p. 263), *Stibasoma fulvohirtum*, a strictly Neotropical form, from "Georgia" also. In the material from Panama before me, there appear to be two species, *D. curvipes* Fab. and another, which Major Dunn had labelled *D. conspicuus* Lutz. It does not entirely agree with that species, of which I have specimens compared with the types, nor with any other described species, and is herein described as new.

The genus may be characterized as follows, based largely on Panama material:

Eyes bare, purple with a variable and often complicated pattern of green lines or spots. Frons broad to narrow, no ocelli or vertexal tubercle. Fronto-clypeus often more or less inflated and shiny. Antennae with the first segment always at least twice as long as the second, generally longer, often somewhat inflated. Second segment as long as wide, the two together at least half the length of the third segment. Third segment of a basal part and four annuli, the basal part is generally equal to or longer than the annulate part, obscurely annulated, and frequently with a blunt dorsal angle. Palpi markedly inflated, as long as proboscis. Proboscis shorter than head height, the fleshy labella more than half total length of proboscis.

Thorax and abdomen unremarkable, much as in *Tabanus*. Legs rather short and stout, the fore tibiae generally more or less inflated and often darker than the other legs. Wings with subepaulet bare, costa, first longitudinal (R1) and at least basal part of fifth vein (Cu) with macrotrichia above; beneath, both costa and subcosta bear macrotrichia. Wings hyaline, with or without costal apical or subapical dark markings. Size small, seldom if ever exceeding 12 mm.

The two Panama species of Diachlorus may be separated as follows:

1. Frons parallel sided, the frontal callus slender, considerably higher than wide. Last two abdominal segments black and wholly black haired. . **jobbinsi**
2. Frons widest in the middle, the frontal callus nearly square. Last two abdominal segments with yellow hairs in the middle. . . . . **curvipes**

Diachlorus jobbinsi sp. nov.

Female—Length 8–10 mm., of wing, 7.5–9 mm.

Frons yellow-pollinose, 5.5 to 6 times as high as basal width, parallel sided. Frontal callus brown, narrower than frons, twice as high as wide and with a slender prolongation above. Fronto-clypeus black, shiny. Genae yellowish grey pollinose. Antennae yellow, the terminal annuli dusky. Palpi yellow, moderately inflated. Thorax mostly yellow pollinose. Mesonotum with a thick, dark trident-shaped figure in the middle, the prongs pointing anteriorly, and a pair of dark isolated shoulder spots. Pleura and sternum between fore and mid legs pearly, otherwise yellow pollinose. Scutellum dark at base, the apex yellow. Legs with all coxae and femora yellow, fore tibiae and tarsi black and black haired, mid tibiae and tarsi yellow, whitish at bases, hind tibiae yellow with some dark hairs, the tarsi whitish at base. Wings hyaline, tinged with yellow in the costal area, and with a black apical spot which includes the whole apex beyond the fork of the third vein, from the costa to the fourth vein (M_1), with sometimes a faint infuscation in the apex of the second posterior cell. Abdomen yellow, first tergite and a broad median stripe from second to fifth tergites yellow haired, otherwise black haired; the two terminal tergites black and black haired. Beneath, the vestiture is wholly yellow, except for the two terminal sternites.

Holotype ♀ and 2 ♀ Paratypes, El Real, Darien Province, Panama, March 20, 1941; 1 ♀ Paratype, El Real, Darien, Feb. 7, 1940 (D. M. Jobbins coll.); 3 ♀ Paratypes, Yape, Darien Province, Panama, Jan. 25, 1940 (D. M. Jobbins coll.).

This species is very close to *curvipes*, but may be distinguished from it by slightly narrower and parallel sided frons, more slender callus, slenderer palpi, black terminal segments of the abdomen, and the presence of dark shoulder spots and absence of median yellow stripe on the mesonotum. From *conspicuus* Lutz it may be distinguished by the yellow margined scutellum, paler legs, and less extensive dark apex to the wing. The species flies in company with *curvipes*, but appears to be less abundant.

Diachlorus curvipes (Fabricius)

(Figs. 3, 3a, 3b)

Haematopota curvipes Fabricius, 1805, Syst. Antl., p. 107 (South America).
Tabanus curvipes Wiedemann, 1821, Dipt. Exot., I, p. 90; 1828, Aussereurop. Zweifl. Ins., I, p. 176 (♀).
Diabasis curvipes Macquart, 1834, Hist. Nat. Ins. Dipt., I, p. 208 (♀). Walker, 1854, List Dipt. Brit. Mus., V, p. 271.

Diachlorus curvipes Williston, 1895, Kansas Univ. Quart., III, 3, p. 193 (♀). Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 138. Ricardo, 1904, Ann. Mag. Nat. Hist. (7) XIV, pp. 358 and 359 (♀). Bréthes, 1907, An. Mus. Nac. Buenos Aires, XVI, p. 284. Kertész, 1908, Cat. Dipt., III, p. 211. Ad. Lutz, 1907, Centralbl. Bakt. Parasitenk., Abt. I, XLIV, p. 142; 1913, Mem. Inst. Osw. Cruz, V, pp. 145 and 189, Pl. XII, fig. 1 (♀). Neiva and Penna, 1916, Op. cit., VIII, p. 94. Bodkin and Cleare, 1916, Bull. Ent. Research, VII, p. 185. Surcouf, 1921, Gen. Insect., Taban., p. 51.

Chrysops afflictus Wiedemann, 1828, Aussereurop. Zweifl. Ins., I, p. 204 (♀; Brazil). Walker, 1854, List Dipt. Brit. Mus., V, p. 288. Hunter, 1900, Trans. Amer. Ent. Soc., XXVII, p. 135. Ricardo, 1904, Ann. Mag. Nat. Hist. (7) VIII, pp. 310 and 313. Kertész, 1908, Cat. Dipt., III, p. 181. Surcouf, 1921, Gen. Insect., Taban., p. 150.

Diachlorus (?) *afflictus* Ad. Lutz, Mem. Inst. Osw. Cruz, V, pp. 163 and 189.

?*Diabasis ataenia* Macquart, 1838, Dipt. Exot., I, p. 152 (in part; specimens from Pará). Walker, 1854, List Dipt. Brit. Mus., V, p. 271.

Chrysops varipes Walker, 1854, List Dipt. Brit. Mus., V, p. 289 (♀; Pará). Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 145.

Diabasis varipes Rondani, 1848, in Baudi and Truqui, Studi Entom., I, p. 105 (no sex; Brazil), (p. 45 of reprint).

Diachlorus varipes Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 138. Ricardo, 1904, Ann. Mag. Nat. Hist. (7) XIV, p. 359. Kertész, 1908, Cat. Dipt., III, p. 213. Surcouf, 1921, Gen. Insect., Taban., p. 51. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 336. Bequaert, 1926, Med. Rep. Harvard Exp. Amazons, Pt. II, p. 223 (Pará; Panama). Kröber, 1928, Beih. z. Arch. f. Schiffs-u. Trop.-Hyg., XXII, 2, pp. 8, 43, fig. 19 (♀; French Guiana; Pará; Iquitos); 1934, Rev. Ent., IV, 2, p. 256.

This species does not appear to be very abundant in Panama, except about the Rio Tuira in Darien Province, where most of my material has come from. It attacks man readily, like other species of the genus.

Distribution: Recorded in the literature from Panama, Venezuela, British and French Guiana, Brazil (States of Pará, Amazonas, Bahia, Sao Paulo), and Paraguay. Dr. Bequaert took the species at Muzo, Dept. Boyaca, Colombia.

Panama records: El Real, Darien Prov., Aug. 11 to 30, 1930 (H. C. Clark coll.; det. Kröber); Jan. 24 and Feb. 7, 8, and 10, 1940 (D. M. Jobbins coll.). Chepigana, Darien Prov., July 22, 1931 (L. H. Dunn coll.). Pihuila, Darien Prov., March 27, 1933 (L. H. Dunn coll.). Margarita Is., near Ft. Randolph, C. Z., June 30 (J. B. Shropshire coll.). Pacora, March 26, 1939. Moja Pollo, Chagres River region, July 23, 1940. Mt. Hope, C. Z., Oct. 30, 1939.

Genus **Stenotabanus** Lutz

1913, Brasil Medico, No. 45, p. 6 (reprint), Dec. 1. (Defined in key, no species); 1914, Mem. Inst. Osw. Cruz, VI, 3, p. 167 (reprinting of 1913 paper); 1922, Zoologia Medica, Publ. Sep. da "Folha Medica," Rio de Janeiro, pp. 9 and 11 (in key, no species). Lutz and Neiva, 1914, Mem. Inst. Osw. Cruz, VI, 2, pp. 73, 74 (*St. taeniotes* Wied. in list of species). Bequaert, 1924, Psyche, XXXI, 1, p. 30 (Type, *Tabanus taeniotes* Wied.). Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 354 (Type *T. taeniodes* (!) Wied., equals Lutz' genus only in that it includes *taeniotes*). Kröber, 1929, Enc. Ent., Dipt., V, p. 113; 1934, Rev. Ent., IV, 2, p. 258 (with 20 Neotropical species). Borgmeier, 1933, Rev. Ent., III, 3, p. 301 (with *Styposelaga* End. as synonym). Stone, 1938, U. S. Dept. Agric., Misc. Pub. No. 305, p. 31 (7 Nearctic species). Bequaert, 1940, Rev. Ent., XI, 1–2, p. 289 (Subgenus of *Tabanus*, 15 Antillean species). Philip, 1941, Can. Ent., LXXIII, pp. 10, 11, 14.

Myiotabanus Lutz, 1928, Est. Zool. Parasit. Venezolanas, p. 58, Pl. 8, fig. 4. (Monotypic for *M. sarcophagoides* n. sp.). Kröber, 1934, Rev. Ent., IV, 2, p. 275 =*Leucotabanus*).

Styposelaga Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 342 (Monotypic for *St. sexannulata* End.).

This genus as here understood includes a considerable number of mostly small flies with the general facies of *Tabanus*. Structurally the genus is quite heterogeneous, and it will eventually be necessary to divide it into more homogeneous groups, but for the present only two of the more obvious forms will be tentatively assigned sub-generic standing.

The genus in the broad sense may be defined as follows: Eyes bare, at least in the female, with or without green or purple bands. Frons medium to very broad, frontal callus present, median and vertexal calli present or absent. Antennae *Tabanus*-like, the tooth on the third segment usually short, rarely prominent, often absent. Annulate portion of third segment usually with 4 annuli, but with a tendency to reduction to 3 or rarely 2 annuli. Proboscis generally short, the labella large and membranous. Wings with all cells but anal open, with or without an appendix on the third vein. Subepaulet typically without macrotrichia but in a few species discussed below, hairs are present to a variable extent. Legs as in *Tabanus*. Thorax as in *Tabanus*, sometimes with iridescent scale-like hairs. Abdomen very variously ornamented.

KEY TO SUBGENERA

1. Frons broad, not more than three and one-half times as high as wide, frontal callus variable, generally wider than high and as wide as frons. Vertexal tubercle absent, rarely a small denuded vertexal area present. Antennae with four well marked annuli....................subg. **Aegialomyia** Philip
   Frons narrow or very broad, frontal callus variable. Vertexal tubercle present, or at least a denuded shiny area at vertex. Antennae variable.... 2
2. Frons relatively narrow, generally at least five times as high as wide. Vertexal tubercle well marked, often with vestiges of ocelli. Antennae with four well marked annuli...........................subg. **Stenotabanus** Lutz
   Frons very broad, hardly twice as high as wide, callus transverse, narrower than frons. Vertexal area with a small shiny spot. Fronto-clypeus with a deep, denuded, pit on each side. Antennae with but three well marked annuli, the terminal annulus a small button, or fused with the preceding annulus....................................subg. (nov.) **Brachytabanus**

Subgenus **Aegialomyia** Philip

1941, Can. Ent., LXXIII, p. 10. (Type *T. psammophilus* O. S.).

Although Philip established the present group as a full genus, I prefer to treat it subgenerically until the Neotropical forms become better known.

The group as here understood includes a number of very broad fronted species which for the most part seem confined to a sea beach or coastal marsh environment.

In addition to the characters given in the key, these species are distinguished by the generally pale coloration, pale legs, often spotted wings, multiple banded eyes, short to very short proboscis, short, stubby antennae, with disproportionately thickened terminal annuli, and abdominal pattern, when present, of a median and lateral row of pale spots on darker ground.

I consider the following described species to belong to this group: *T. psammophilus* O. S., *T. atlanticus* Johns., *T. nervosus* Curran, *T. caribaeorum* Bequaert, *T. laevicallus* Szilády, *T. jamaicensis* Newstead, and *T. magnicallus* Stone. The males, known for *psammophilus*, *caribaeorum*, *atlanticus*, *nervosus* and *magnicallus* have the eyes bare, the large facets very extensive and sharply differentiated and demarkated from the small facets, and there is no vertexal tubercle. Two species of the group occur in Panama, both apparently undescribed, and each represented by but a single female specimen.

Stenotabanus (Aegialomyia) paitillensis sp. nov.

(Figs. 12, 12a, 12b)

Female—Length 8 mm., of wing 7 mm. Eyes bare, in life with the upper and lower margins broadly purple, the broad green median area crossed by two narrow purple bands set close together, or the eye may be said to be purple with two broad and one narrow green band. Frons as figured, brownish grey pollinose, the frontal callus mahogany brown, markedly protuberant, vertexal area a little denuded, but without a definite callus or tubercle. Subcallus and facial area brownish above, grey beneath, the beard white. Antennae as figured, yellowish throughout. Palpi as figured, white with dark and light hairs mixed.

Mesonotum and scutellum pale brown, the former with two very faint stripes. Pleura grey, whitish haired. Legs uniformly pale brown, the fore tibiae faintly dusky at apex. Wings hyaline, upper branch of third vein with a rather long appendix. Abdomen pale brown, the tergites broadly grey behind, and with a mid-dorsal row of grey triangles. There is also a dorsolateral row of rounded grey spots broadly joined to the hind marginal band.

Holotype ♀, Paitilla Airport, Panama, March 19, 1941, to be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass.

This little species appears to be related to *littoreus* Hine, and *campechianus* Towns. From the first of these it may be distinguished by smaller size, differently marked eyes and abdomen, broader antennae, and wholly pale legs, and from the latter by abdominal pattern.

Stenotabanus (Aegialomyia) changuinolae sp. nov.

(Figs. 5, 5a, 5b)

Female—Length 12 mm., of wing 11 mm. Eyes bare, the pattern not revivable. Frons as figured, brownish grey, the callus mahogany brown. Antennae as figured, brown, the hairs on first two segments black. Subcallus and face pale brown; beard sparse, whitish. Palpi as figured, pale brown, mostly pale haired. Proboscis hardly longer than palpi, brownish.

Mesonotum and scutellum cocoa brown, with four fairly prominent paler stripes. Pleura concolorous. Legs wholly brown, mostly white haired. Wings very dirty, but apparently hyaline with very small clouds on at least the distal cross veins. Fork of third vein with a short appendix. Abdomen somewhat crushed, but apparently uniformly pale brown.

Holotype ♀, Changuinola Dist., Bocas del Toro Prov., Panama (L. L. Pechuman leg.). The species seems quite closely related to *laevicallus* Szil. and *jamaicensis* Newst., but the frons is even broader, the third antennal segment considerably wider, and the size larger. The specimen is not in the best condition, so that fresh material will be necessary to define its relationships with the West Indian species more clearly.

Subgenus **Brachytabanus** subg. nov.

I am creating this name for the reception of *Stenotabanus longipennis* Kröber, which seems to me to be sufficiently distinct from other *Stenotabanus* known to warrant separation.

The subgenus may be defined as follows: Female eyes bare, green with three narrow purple bands in life. Frons very broad, less than twice as high as wide. Frontal callus wider than high, very convex. Vertexal tubercle represented by a broadly crescentic transverse ridge, with a small bare area above it. Subcallus pollinose, without hairs. Anterior tentorial pits greatly enlarged, black and shiny within. Third antennal segment with basal part longer than wide, dorsal angle very obtuse. Annulate portion with a tendency to reduction, so that there are often but three visible annuli, the fourth being very small and more or less fused with the third. Wings rather long and narrow, with macrotrichia on the costa, subcosta and first vein above, and with a very short appendix or none.

Stenotabanus (Brachytabanus) longipennis Kröber

(Figs. 4, 4a, 4b)

Stenotabanus longipennis Kröber, 1929, Enc. Ent., Ser. B, Dipt., V, p. 125, Pl. I, fig. 23; Pl. II, figs. 7, 37; Pl. III, fig. 55 (♀; Venezuela); 1934, Rev. Ent., IV, 2, p. 258.

This peculiar little species does not seem to be very closely related to any species with which I am familier. The antennae are reminiscent of *Microtabanus pygmaeus* Will., but there the similarity stops. Kröber's description and figures are excellent, but omit one character which seems peculiar to this species.

On each side of the clypeus are two grooves, the anterior tentorial pits of Snodgrass, which in many Tabanids have a tendency to form rounded pits at their lower ends, but in this species these pits are greatly enlarged and shiny black within, so that they appear as round, black spots or holes on each side of the otherwise greyish pollinose face. The whole insect is light brown, the legs yellowish, the abdomen with a broad creamy haired mid-dorsal stripe, on each side of which the abdomen is blackish haired to about the same width as the stripe, the sides of the tergites being again broadly light haired. The wings seem unusually long and narrow.

Distribution: Venezuela, Colombia and Panama. A specimen before me labelled Venezuela, Nov., 1936 (Anduze), agrees perfectly with Panama material, while there is a series of 14 ♀ from Muzo and Villavicencio, Colombia, in Dr. J. Bequaert's collection.

Panama records: 1 ♀, Gamboa, C. Z., July 9, 1924 (N. Banks); 2 ♀, Utevey, near Pacora, Aug. 6, 1941, on horse.

Subgenus **Stenotabanus**

This group includes a large number of small species with relatively narrow frons, usually well developed vertexal tubercle, and often a dark hair patch in the position of the median callus. The group includes *T. taeniotes* Wied. (the Genotype), *T. fulvistriatus* Hine, *T. maculifrons* Hine, *T. flavidus* Hine and probably a considerable number of other species, though further study of actual material will be necessary before placing most of them.

St. plenus Hine belongs to a group of species including *St. tantulus* Hine, *muscoideus* Hine and *sarcophagoides* Lutz. They are characterized by a narrow club-shaped callus, wholly dark legs, and eyes with a single green band or none. The species all bear a striking superficial resemblance to Muscoid or Sarcophagid flies. If further study of the group shows the advisability of separation, the name *Myiotabanus* Lutz is available, though as only one species occurs in Panama, it seems best to leave it in *Stenotabanus* for the time being.

The eight remaining species before me from Panama fall into two rather distinct groups. *Fulvistriatus*, *minusculus*, *maculifrons*, *constabulorum* and *calvitius* are all small species with a more or less extensive shiny vertexal area surrounding the tubercle, a callus as wide as the frons, usually with a dark hair patch in the middle of the frons, and with unmarked wings.

Lerida, *jaculator* and *pequeniensis* are without the shiny vertexal area or mid-frontal hair patch, the callus is narrower than frons, and the wings are spotted. This last group is rather anomalous, as all three species may have hairs on the subepaulet. *Lerida* usually has this structure bare, but may have from one to three strong macrotrichia, *pequeniensis* nearly always has a few macrotrichia, up to 12 on a side, while in *jaculator* macrotrichia are abundant, though more sparse than on the adjoining costa. It is with some trepidation that these species are retained in *Stenotabanus*. They might with almost equal justification be considered an aberrant group of *Tabanus*. The characteristic wing pattern, the well marked vertexal tubercle bearing vestiges of ocelli, and the general habitus seem to me to place them somewhat closer to such species as *St. parvulus* Will. and *St. brunettii* Beq., which have bare subepaulets, than to *lucidulus* Walk. which Bequaert places in *Macrocormus*. The latter has a very similar wing pattern, but lacks a vertexal tubercle and the subepaulets bear macrotrichia. The use of the subepaulet in Tabanid classification has proven very useful, but this is one case where it seems to confuse rather than clarify. It would be quite impossible to place these species correctly in Philip's (1941) key to Nearctic Tribes and Genera, as any placement would allocate the obviously closely related species into different Tribes, and even in some cases necessitate the placing of different specimens of the same species in different categories. Although it is important to call attention to such cases, it seems foolish to abandon the subepaulet character on the grounds that it will not always work. The fact that intermediate forms exist is in reality a valuable clue to phylogenetic relationships.

KEY TO FEMALES

1. Frontal callus narrower than frons. A vertexal tubercle, but no denuded patch at vertex. Palpi rather slender, not markedly inflated basally...... 2
   Frontal callus as wide as frons. A shiny area of variable extent surrounding vertexal tubercle. Palpi markedly inflated basally...................... 5
2. Stout thickset species. The thorax black with four prominent grey stripes, abdomen black with the first two tergites with whitish bloom, 2nd to 6th tergites with whitish hind margins and yellow haired median triangles. Legs black. Wings hyaline and with a small dark area from stigma to apex of second basal cell. Basal part of third antennal segment broad, and with a strong dorsal angle.................................. **plenus**
   Slender species, the thorax unstriped, wings with cross veins clouded, and antennae without a strong dorsal angle................................ 3

3. Abdomen light brown, a black median tegumentary spot on second tergite, and all tergites prominently pale margined behind. Wing faintly smoky, all veins narrowly brown margined and strong clouds on all cross veins and fork of third vein. Appendix long. . . . . **lerida**
   Abdomen immaculate, or with faint pale hind marginal bands. Wings smoky mainly apically and along fore border. Veins not brown margined. . 4
4. Frons distinctly convergent below. Wings heavily fumose apically. Third vein with a moderate to long appendix. . . . . **pequeniensis**
   Frons parallel sided. Wings lightly fumose along fore border. Third vein without an appendix. . . . . **jaculator**
5. Wings markedly fumose along fore border. Abdomen light brown with a broad creamy mid-dorsal stripe from scutellum to apex. Frons without median dark hair patch. Legs largely yellow. . . . . **fulvistriatus**
   Wings entirely hyaline. Abdomen black or dark brown, without a median stripe. Frons always with at least a small median black hair patch. Legs largely black. 6
6. Thorax prominently striped. Scutellum dark with a wide pale border. All tergites prominently pale margined behind. **minusculus**
   Thorax unicolorous or with golden or greenish hairs, not striped. At least the first tergite dark. 7
7. Thorax and abdomen entirely blackish above. Tergites narrowly and faintly pale behind, but without pale hairs. Frons narrow and convergent, the callus nearly twice as high as wide. . . . . **constabulorum**
   Thorax and abdomen with pale hairs. Tergites prominently pale and pale-haired behind. Frons broader, the callus as wide as high. 8
8. Subcallus denuded and shiny. Whole vertex black, denuded and shiny. Scutellum and third to sixth tergites densely golden haired behind. . **calvitius**
   Subcallus pollinose. Vertex with but a small denuded area surrounding tubercle. Scutellum without dense golden pilosity. Tergites two to six with narrow whitish hind marginal bands. **maculifrons**

Stenotabanus (**Stenotabanus**) **fulvistriatus** (Hine)

(Figs. 11, 11a, 11b)

Tabanus fulvistriatus Hine, 1912, Ohio Naturalist, XII, 7, p. 515 (♀; Chiapas, Mexico). Surcouf, 1921, Gen. Insect., Taban., p. 69. Kröber, 1934, Rev. Ent., IV, 3, p. 309 (not seen).
Tabanus unistriatus Dunn, 1934 Psyche, XLX, 3, p. 174 (in part).

There are two specimens in the Hine collection, one labelled "Dona Maria, Chiapas (Crawford)" and "Type," the other from Higuito, San Mateo, Costa Rica. The type has slightly broader antennae and a slightly narrower frons. Material from Panama which I compared with these specimens agrees best with the Costa Rica specimen. The species is exceedingly close to *taeniotes* Wied., of which I have specimens from Southern Brazil. The only differences I can discover are the more brownish wings of *fulvistriatus*, the more slender antennae of *taeniotes* and the presence in the latter of very narrow light hind margins to the tergite. *St. peruviensis* Kröb. and *St. pallidicornis* Kröb. from Peru and Bolivia also seem very close.

Distribution: Southern Mexico, Costa Rica, Panama.

Panama records: 3 ♀, Puerto Armuelles, Chiriqui Prov., July 27, 1929 (L. H. Dunn; det. as *unistriatus* Hine).

Stenotabanus (Stenotabanus) maculifrons (Hine)

(Figs. 8, 8a, 8b)

Tabanus maculifrons Hine, 1907, Ohio Naturalist, VIII, 2, p. 222 (♀; Puerto Barrios, Guatemala). Surcouf, 1921, Gen. Insect., Taban., p. 74. Kröber, 1934, Rev. Ent., IV, 3, p. 311 (not recognized).

The types in the Hine collection consist of 2 ♀, Puerto Barrios, Guatemala, March 4 and 7, 1905. My material consists of 1 ♀ from Chilibre, Madden Highway, Panama, Jan. 1, 1940, and 1 ♀, Restrepo, Dept. Meta, Colombia (Antunes coll.), and differs in no way from the types. The Colombian specimen was determined for me in 1936 as *St. sexannulatus* End. by Dr. G. M. de Oliveira Castro. The species are certainly exceedingly close, but Kröber's figures (Op. cit., 1934, p. 122 and figs.) show a rather narrower and more convergent frons for *sexannulatus*. Since I have seen no specimens from anywhere near the type locality (Bolivia) it seems best to keep the two separate for the present.

Distribution: Guatemala, Panama and Colombia.

Panama records: Only the single female referred to, which was taken on the screens of a house.

Stenotabanus (Stenotabanus) constabulorum sp. nov.

(Figs. 6, 6a, 6b)

Female—Length 8.5 mm., of wing 8 mm. Eyes bare, purple with two narrow green bands in life. Frons as figured, yellowish grey pollinose, with a large black haired median area. Subcallus and face yellowish grey, beard greyish. Antennae as figured, dark reddish, the apical half of third segment blackish. Palpi as figured, brownish, mostly black haired. Proboscis short, hardly longer than palpi, dark brown.

Mesonotum and scutellum black, unstriped, sparsely grey pollinose, and with sparse brassy scale-like hairs. Pleura yellowish grey and creamy haired above, steel grey below. Legs with coxae and femora black, fore tibiae half, posterior tibiae three-fourths white basally, otherwise black. Tarsi black. Wings hyaline, the costal cell and basal area faintly yellowish. There is a short appendix on the third vein. Abdomen black, the tergites very narrowly reddish behind, and bearing a small tuft of yellowish hairs in the middle and extreme sides. Venter greyish pollinose, all sternites whitish, and white haired behind.

Holotype ♀, Police Station, Pequeni River, Madden Lake, C. Z., May 11, 1940.

This species agrees quite well with Kröber's description of his *St. obscurus*, except that the frons is entirely different, being 8 instead of 3½ times as high as wide, and definitely convergent.

Named in honor of the Canal Zone Police force, whose hospitality has afforded me the opportunity for much valuable collecting.

Stenotabanus (Stenotabanus) minusculus (Kröber)

(Figs. 7, 7a, 7b)

Pseudocanthocera (?) *minuscula* Kröber, 1930, Zool. Anz., XC, 3–4, pp. 80–81, fig. 21 (♀; Vulcan Colima, Mexico); 1934, Rev. Ent., IV, 2, p. 260.

A series of specimens before me from Panama agree in most respects with Kröber's description and figure. My material differs, however, in the white or partly white tibiae, a character not mentioned by Kröber. The species has little or nothing in common with *Ps. sylveirii* Macq., the genotype. I give below a description of the Panama material for comparison with Kröber.

Female—Length 7–8 mm., of wing 7 mm. Eyes bare, purple with two narrow green bands in life. Frons as figured, yellowish grey with an extensive median dark patch. Callus and bare vertexal area black. Subcallus and face yellowish grey, beard yellowish. Antennae as figured, dull yellowish brown, the annulate portion darker. Palpi as figured, yellowish brown, mostly white haired. Proboscis but little longer than palpi, blackish.

Mesonotum blackish brown, with two wide dorsal stripes and the lateral margins yellowish pollinose, the whole with scattered dark and brassy hairs. Scutellum black, broadly yellowish grey margined behind. Pleura yellowish grey, darker below, yellow haired and with a brown dark haired stripe extending forward from the wing bases. Legs variable, the femora black to yellowish brown, black haired, the fore tibiae bicolored, white basally, black apically; posterior tibiae largely white and pale haired. Tarsi dark. Wings hyaline, with or without a short appendix. Abdomen black, or with the anterior tergites partly or wholly cinnamon brown. First, and to some extent the second, tergites with a grey bloom; all tergites conspicuously yellowish or whitish on hind margins, and with pale hairs. These transverse bands may be slightly wider in the middle, but do not form distinct triangles. The band on the first tergite is narrower than the others. Sternites grey pollinose, the hind margins whitish. The striped thorax of this species will distinguish it from *maculifrons* Hine. Kröber's *obscurus* also appears to be close, but the thorax is unicolorous.

Panama records: 2 ♀, Juan Mina Station, Chagres River region, C. Z., Feb. 8 and March 9, 1939; 2 ♀, Moja Pollo, Chagres River region, Feb. 16, 1940; 1 ♀, Pacora, March 26, 1939; 1 ♀, El Real, Darien Province, Feb. 8, 1940; 1 ♀, Darien (Dunn).

Stenotabanus (Stenotabanus) plenus (Hine)

(Figs. 15, 15a, 15b)

Tabanus plenus Hine, 1907, Ohio Naturalist, VIII, 2, p. 225 (♀; Izabal, Guatemala). Surcouf, 1921, Gen. Insect., p. 79. Kröber, 1934, Rev. Ent., IV, 3, p. 313.

The types in the Hine Collection consist of 6 ♀ from Izabal, March 7, 1907, in fair condition. The abdomens are somewhat reddish at base. There are also 5 ♀ from Higuito, San Mateo, Costa Rica (Schild coll.) in the Hine collection. Hine's description is good, but may be supplemented in a few details. A small though definite tubercle is situated in a small bare area on the vertex. The abdomen bears median dorsal triangles of light hairs, and the tergal hind marginal fringes mentioned by Hine may be continuous or interrupted on each side of the median triangles. I have also seen 1 ♀, Guatemala City and 1 ♀, El Rancho, both Guatemala, in Coll. Bequaert.

Distribution: Guatemala, Costa Rica, Panama.

Panama records: Porto Bello, Feb. 24, 1911 (Busck), El Valle, Cocle Prov., April 13, 1941. Moja Pollo, Chagres River region, Jan. 11, 1941.

Stenotabanus (Stenotabanus) calvitius sp. nov.

(Figs. 10, 10a, 10b)

Female—Length 8 mm., of wing 6.5 mm. Frons about three and one-half times as high as basal width, rather convergent, grey pollinose with a wide transverse band of black pollinosity in the region of the median callus. The frons is also rather well covered by long decumbent hairs. Basal callus black, as wide as frons, about as wide as high, broadly joined to the inverted club-shaped median callus. Vertexal tubercle well marked with vestiges of three yellowish ocelli. Whole vertex to below tubercle denuded, shiny black. Subcallus denuded, black and shiny, with but a narrow grey pollinose strip along eye margins. Eyes bare under a hand lens, but showing sparse and scattered hairs under higher power. Eyes in life purple, the upper and lower margins dark green, and with two fairly broad golden-green median transverse bands. Fronto-clypeus and genae grey pollinose, the latter with a pale straw colored beard. Antennae dark reddish throughout, the first two segments with black hairs. Palpi blackish, thinly grey pollinose, and with abundant and long pale yellow hairs, and shorter black hairs. Proboscis about one-half longer than palpi, black, the labella more than half its length, fleshy.

Mesonotum black, thinly dark grey pollinose, fairly well covered with greenish golden iridescent hairs. Scutellum densely clothed with long bright golden hairs. Pleura dark grey, with sparsely grey hairs. Wings hyaline, the stigma black, no appendix on fork of third vein. Legs black, the basal half of fore tibiae white and white haired, the mid and hind tibiae wholly white, except extreme apices, and the mid and hind basitarsus also white, or yellowish. First two tergites black and black haired, except at extreme postero lateral angles, which are yellow haired. Tergites 3 to 5 with pale pollinose and yellow haired hind marginal bands, widened in the middle and at the sides. Sternites dark grey pollinose, all with pale haired hind marginal bands.

Holotype ♀, Panama City, Republic of Panama, Jan. 10, 1942. Taken on windows of automobile. To be deposited in the Museum of Comparative Zoology.

This little species seems closest to *maculifrons* Hine and *sexannulatus* End. It differs from the former in its more brilliant coloring and lack of a pale hind marginal band on the second tergite and from the latter by its heavily golden haired scutellum and lack of anything approaching a series of connected mid-dorsal triangles on the abdomen. From both species it differs in having a bare subcallus and the whole vertex bare and shiny.

Stenotabanus (Stenotabanus) lerida sp. nov.

(Figs. 14, 14a, 14b)

Female—Length 10–11.5 mm., of wing 10.5–11 mm. Eyes bare, apparently green with a single purple band in life. Frons a little over five times as high as basal width, slightly narrowed below, yellowish brown pollinose. Frontal callus dark brown, higher than wide, narrower than frons, and prolonged in a slender line two-thirds the distance to the vertex. Vertexal tubercle present, and with traces of three ocelli. Subcallus yellowish pollinose, with sparse long whitish hairs. Frontoclypeus and genae grey, sparsely greyish haired. First two antennal segments yellowish, black and pale haired. Basal part of third segment orange, longer than wide, the dorsal tooth small and near base. Annulate portion black, shorter than basal portion. Palpi pale brownish, slender, mostly black haired. Proboscis brown, but little longer than palpi; the labella membranous, large, over half length of proboscis.

Mesonotum and scutellum brown, indistinctly greyish striped and with sparse golden hairs. Pleura, sternum and coxae grey pollinose, rather abundantly grey haired. Legs light brown, the tarsi and apices of fore tibiae darker. Femora pale haired, tibiae and tarsi mostly dark haired. Wings with subepaulet bare, but with macrotrichia upon costa, subcosta and first and fifth veins above, costa and subcosta beneath. Wings faintly smoky, darker along costa and hind margin, and with prominent clouds on all cross veins. Upper branch of third vein long appendiculate, costal cell yellow. Abdomen orange brown, darker towards apex, the hind margins of all tergites paler and yellow haired, rest of tergites dark haired. The second tergite, and rarely the third, bears a median black integumental spot. Venter pale reddish brown, mostly pale haired.

Holotype ♀ and 7 ♀ Paratypes, Boquete, Chiriqui Province, Panama, March-April, 1941 (Mrs. T. B. Monniche coll.); 9 ♀

Paratypes, same locality, April, 1940 (Mrs. T. B. Monniche coll.); 1 ♀ Paratype, Cerro Punta, Chiriqui Province, Feb.-March, 1940, 6,000 ft. (T. T. Howard coll.).

This little species belongs to a rather widespread tropical American group including the West Indian *St. brunettii* Bequaert and *St. batesi* Bequaert and a considerable number of as yet unnamed continental species.

Stenotabanus (**Stenotabanus**) **pequeniensis** sp. nov.

(Figs. 13, 13a, 13b)

Female—Length 10–12 mm., of wing 9–10.5 mm: Eyes bare, uniformly green in life. Frons narrow, about six and one-half times as high as basal width, yellowish brown pollinose. Basal callus black, about twice as high as wide, nearly as wide as frons, and prolonged above in a slender line two-thirds the distance to the vertex. Vertexal tubercle present, small, but often with vestiges of ocelli. Subcallus orange brown pollinose. Fronto-clypeus and genae greyish pollinose, the latter with a sparse grey beard. Antennae yellowish brown, the terminal annuli darker. First and second segments not swollen, black haired. Basal part of third segment a little longer than annulate portion, and somewhat longer than broad. Dorsal angle moderate, with a tuft of black hairs. Palpi brownish, black haired, slender, nearly as long as antennae. Proboscis a little longer than palpi, brown, the labella about half length of proboscis, fleshy.

Mesonotum dark brown, dark haired, unstriped. Pleura and sternum greyish. Legs dark brown, the coxae greyish pollinose and grey haired. Subepaulet with macrotrichia, but much less densely hairy than costa. Costa, subcosta, first and basal part of fifth veins with macrotrichia above, costa and subcosta also hairy beneath. Upper fork of third vein with a short appendix. Whole wing fumose, but definitely darker along costa and at apex. Cross veins with small dark clouds. Abdomen yellowish brown, darker towards apex, black haired, rarely with faint indications of yellowish mid-dorsal triangles. Venter paler, with pale hairs.

Holotype ♀, Rio Pequeni, Madden Lake, Panama, Aug. 21, 1941; 2 ♀ Paratypes, same data; 1 Paratype, Rio Pequeni, May 11, 1940; 1 ♀ Paratype, Moja Pollo, Chagres River region, C. Z., May 15, 1940; 4 ♀ Paratypes, Cerro Azul, near Pacora, Panama, May 17, 1940; 3 ♀ Paratypes, Meta, Colombia (in coll. J. Bequaert). Holotype and 3 Paratypes to be deposited in the M. C. Z., Harvard University, Cambridge, Mass.

This little species appears to be related to *T. lucidulus* Walker of Jamaica, for which Bequaert (1940) uses the subgeneric name *Macrocormus*, and from which it differs in unmarked abdomen and more slender palpi. *T. modicus* Hine, from British Guiana, appears also to be close, but is considerably darker and with slightly different frons and antennae. I have seen Hine's unique type.

Stenotabanus (Stenotabanus) jaculator sp. nov.

(Figs. 9, 9a, 9b)

Female—Length 8–10 mm., of wing 9–9.5 mm. Eyes bare, the color pattern not revivable in the material at hand. Frons medium, about five times as high as basal width, parellel sided, steel grey pollinose. Frontal callus black, slightly narrower than frons, square below, about twice as high as wide and merging gradually into a slender line which reaches two-thirds of the distance to the vertex. Vertexal tubercle small, but distinct, with vestiges of ocelli. Subcallus, fronto-clypeus and genae pale grey pollinose, only the last two with sparse pale hairs. First two antennal segments pale yellowish, slightly inflated, black haired. Basal part of third segment orange, longer than wide, longer than annulate portion, and with an obtuse non-salient dorsal angle. Annulate portion somewhat dusky. Palpi pale brown, black haired, rather slender and not acutely pointed. Proboscis brownish, the fleshy labella over one-half its length.

Mesonotum pale reddish brown, grey pollinose. Pleura, sternum and coxae grey pollinose. Legs rather uniformly pale brown. Wings above with subepaulet, costa and first vein with macrotrichia, subcosta with a few hairs in the middle section, fifth vein wholly bare. Wings smoky, especially along the costa, and all cross veins with small clouds. Abdomen pale reddish brown, without apparent markings.

Holotype ♀ and 1 ♀ Paratype, Bohio, C. Z. (A. H. Jennings); 2 ♀ Paratypes, Las Cascadas, C. Z. (A. H. Jennings).

All of the types are old and somewhat rubbed, but the species is quite distinct on frontal characters. It comes nearest *pequeniensis*, but is smaller, paler throughout, and has a broader, more parallel sided frons. Some of these specimens were labelled *parallelus* Wlk., but although the resemblance is great, that species has a bare subepaulet, and a quite different frons.

THE RELATION OF THE PREY OF SPHECIUS SPECIOSUS TO THE SIZE AND SEX OF THE ADULT WASP

(Hym.: Sphecidae)

Richard Dow,
Reading, Mass.

It has frequently been observed that the female cicada killer, *Sphecius speciosus* (Drury), provisions each cell of her nest with one or two cicadas. As the sexes of the adult wasp show a considerable difference in average size, the male being much smaller, it is natural to ask: does the sex of an adult bear any relation to the amount of prey with which its cell was provided? In other words, are the sex and size of the adult wasp directly correlated with the number and weight of the stored cicadas? Though I am far from reaching any final answers, it seemed worth while to put my present results on record, especially as they suggest one or more promising lines of investigation which I have no immediate prospect of being able to follow.

SEX OF ADULT WASP AND NUMBER OF STORED CICADAS

On August 28, 1937, in an area of coarse sandy soil in Berkley, Massachusetts, to which I was directed by Mr. N. S. Easton of Fall River, I excavated the contents of more than forty cells of *speciosus*. These cells were grouped in the vicinity of two burrows about a yard apart, but it is doubtful that they belonged to only two nests. In fact, I did not attempt to find them by tracing their connections, but having dug a fairly deep hole into which the loose dirt could fall, merely scraped away the sides of the pit. (This is a useful method even if one is excavating a burrow probed with the flexible stem of a plant.)

The larva of *Sphecius speciosus* differs from that of most aculeate wasps in leaving the exoskeleton of the prey practically intact. Consequently, from 42 cells, I was able to obtain the remains of 66 cicadas, partially dismembered, but in such condition that it was not only possible to tell the species and sexes involved but to give the exact contents of each cell. In the work of identifying this material, partly on the basis of the terminal segments of the female and the opercula of the male, I received much help from Dr. Charles H. Blake. *Tibicen canicularis* (Harr.) was represented by 14 males and 27 females, and *T. lyricen* (Deg.) by 10 males and 17 females, a total of 24 males as against 44 females. This agrees with the observations of W. T. Davis (1921: 128), who says of the cicadas caught by the wasp: "The female *Sphecius* seeks them, not by the song of the males as is sometimes stated, but by flying carefully along the limbs of trees and up and down the trunks, and so catches both sexes. In some of the burrows dug out, there were many more females than males." The smaller number of male victims does not imply an irregular sex ratio in the cicadas. It might be that the females are less active (hence more susceptible to capture), longer lived (therefore more abundant during the nesting period of the wasp), or more likely to occur where the wasp will find them. There is also the possibility that there is some selection on the part of the wasp.

In 18 of the 42 cells mentioned above, I failed to discover any stage of the wasp, even empty cocoons. The rest contained cocoons which had been completed, at least externally. Two of these were broken accidentally in the process of excavation, but from the remaining 22, I subsequently reared 18 adults.

In two cells not otherwise considered in the present study, the remains of prey were associated with opened cocoons from which wasps had apparently emerged. Since *speciosus* has but one generation a year, this discovery indicates that the contents of a cell may persist in a recognizable state over at least one winter, and that some of the 18 cells without cocoons may have belonged to nests of other years. The importance of these details will become obvious in the discussion.

It was apparent, even while I was excavating the cells, that the cocoons were of two different classes in respect to size. Subsequent measurements of their length and weight showed that the two groups were quite distinct, and separated by intervals of 5.0 mm. and 1.0 g.

One of the most unexpected results of my observations was the discovery of two cells which apparently contained three cicadas, and though another was recorded in my field notes as having been stored with two specimens of the prey, the remains of three cicadas were later found in the material belonging to this cell. Unfortunately, none of these cells contained cocoons.

TABLE I

DATA PERTAINING TO THE CELLS FROM WHICH ADULTS WERE REARED

Number of cicadas in cell	1	1	1	1	1	1	1	1	1	1	2 ?	2	2	2	2	2	2	2
Tibicen canicularis	♂	♂	♂	♂	♀	♀	♀				♂, ♀	♂, ♀	♀, ♀	♀, ♀	♀	♀		
Tibicen lyricen								♂	♂	♀					♀	♀	♀, ♀	♀, ♀
Estimated weight of prey (g.)	0.93	0.93	0.93	0.93	1.12	1.12	1.12	1.39	1.39	1.94	2.05	2.05	2.24	2.24	3.06	3.06	3.89	3.89
Length of cocoon (mm.)	24.0	29.5	29.5	29.5	29.5	29.5	31.0	32.0	31.0	32.0	31.0	32.0	40.0	39.0	40.5	39.5	40.5	40.5
Weight of cocoon (g.)	0.67	1.05	1.30	1.25	1.14	1.28	1.37	1.39	1.59	1.48	1.30	1.62	2.96	2.96	3.40	3.16	3.15	3.33
Weight of adult (g.)	0.13	0.25	0.28	0.43	0.27	0.36	0.38	0.36	0.42	0.39	0.43	0.44	0.63	0.69	0.81	1.09	0.61	1.06
Sex of adult	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀	♀

Of the remaining cells, 21 were definitely stored with one cicada, and 11 of these contained small cocoons from which I reared 10 males. Either 17 or 18 cells were stored with two cicadas, and 9 of these contained large cocoons from which I reared 6 females. The cell whose contents were doubtful in respect to the number of victims, and another which was certainly provisioned with two cicadas, each contained a cocoon that belonged to the smaller of the two classes and subsequently produced a male wasp. This shows that the number of victims stored in a cell was not perfectly correlated with the sex of the resulting wasp. (See figure 1 and table I.)

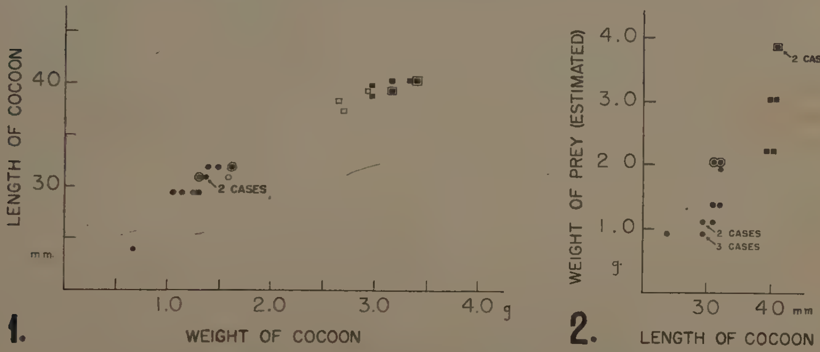


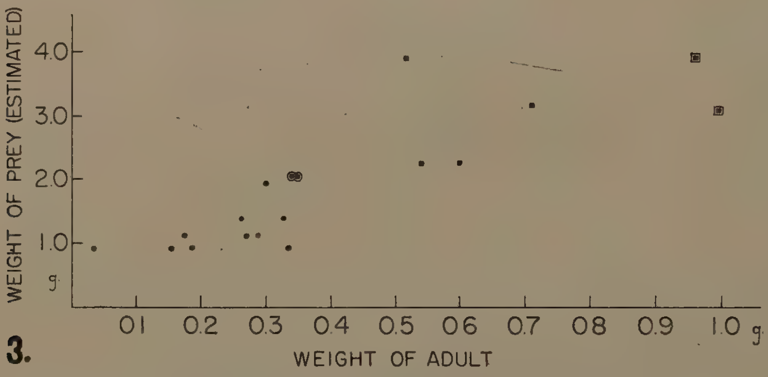
FIG. 1. Weight of cocoon plotted against length of cocoon.
FIG. 2. Length of cocoon plotted against estimated weight of prey.

KEY TO SYMBOLS USED IN GRAPHS

Circular symbols represent data pertaining to cells which produced, or were likely to produce, males. *Square symbols* represent corresponding data for females. The *plain circle* and the *plain squares* refer to cocoons which failed to produce adults, or were prevented from doing so. The *round dots inside circles* represent data pertaining to the two cells which produced males but were provisioned with two cicadas (one case doubtful). The *square dots inside squares* represent data pertaining to the cells whose cocoons produced females with imperfect wings.

SIZE OF ADULT WASP AND WEIGHT OF STORED CICADAS

There remains for consideration the correlation of the total weight of the stored cicadas with the length of the cocoon and the weight of the adult wasp. As noted above, the larva of *Sphecius speciosus* leaves recognizable remains of the prey. On the other hand, without excavating the cells before the larva has begun to feed, there is no way of getting an accurate figure for the weight of the victims. Having no data of this sort, because of the season when my excavations were made, I obtained some freshly captured cicadas in 1938, and from the weights of these specimens, estimated those of the prey stored the previous year. Though I had only two males and one female of *Tibicen canicularis*, and one male and two females of *T. lyricen*, it is apparent from figure 2 that the different combinations of the two species and two sexes of the cicadas give an evenly graded series of weights, and that there is no conspicuous break between the combinations of one and two cicadas, or between those in the cells which produced males and those in the cells which produced females. A still lighter combination of two cicadas, which was possible but did not occur in any of the 42 cells, was two males of *canicularis*. According to my figures, this would be somewhat lighter than a single female of *lyricen*.



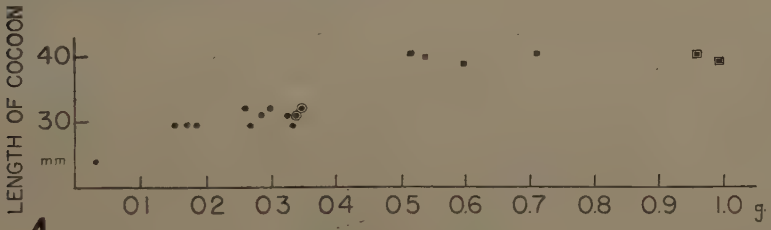
3.

FIG. 3. Weight of adult plotted against estimated weight of prey. (See legend accompanying figs. 1 and 2.)

The relation between the weight of the reared adults and the estimated weight of the prey is shown in figure 3. In this graph the difference in weight of the two sexes of the wasp is in very obvious contrast to the uniform gradation in the weight of the prey. Whether additional data would show as clear-cut relationships is, of course, very doubtful.

A graph of the weight of the adults plotted against the length of the cocoons (figure 4) shows fairly good correlation, especially when allowance is made for the two heaviest females, both of which were specimens that failed to develop perfect wings.

On the whole it is surprising that the graphs are at all satisfactory. They are not only based on few data, but the measurements themselves are subject to criticism. In the first place, aside from the fact that the actual victims could not be weighed, one may question the significance of the weight of the cicadas inasmuch as the larvae do not consume all of their prey. In the second place, the weight of a fresh cocoon is not necessarily an accurate index of the size of the pupa it contains, because the actual cocoon includes a large amount of inorganic material. In the third place, the present measurements of the adults are not too reliable because of the following factors: (1) Three or more of the cocoons had been opened for inspection. (2) The wasps were late in reaching maturity (August 8 to September 10, 1938), probably because of the necessarily artificial conditions under which they were reared. (3) The specimens were weighed both alive and dead varying periods of time after reaching complete development. (4) Two abnormal females are included.



4.

FIG. 4. Weight of adult plotted against length of cocoon. (See legend accompanying figs. 1 and 2.)

From the above results, however, two tentative conclusions may be drawn. First, the weight of the adult wasps was roughly proportional to that of the prey with which their cells were stored. Second, although the sexes of the reared adults formed two separate classes in respect to weight, there was no corresponding segregation in the estimated weights of the provisions.

DISCUSSION

The finding of a general agreement between the number of stored cicadas and the sex of the adult wasp was not particularly surprising in itself, nor does there seem to be any reason to believe that my records were abnormal. In fact, the possibility that such a situation might exist was suggested long ago by C. V. Riley (1892: 250), in the following statement: "In the cells containing two Cicadas the larva acquires larger size, and as the female wasp is a good deal larger than the male, this should indicate that one Cicada only is required for the latter and two for the former, though I have no idea that the amount of nourishment influences the sex (a favorite theory with some naturalists) for I believe that sex is predetermined in the egg."

An experimental approach to this problem was tried in the summer of 1938. The procedure was to give an additional cicada to wasp larvae that had been provided with only one, and to take away from larvae with two cicadas the second victim. By this means, I hoped to discover the effect of increased and reduced amounts of prey. Unfortunately I did not have sufficient time for this work, and my few experiments ended in failure.

At first my own line of thought was to wonder if the quantity of stored food could have any influence on the sex of the wasp, or if there might be any mechanism whereby the female could either provision a cell with an amount of prey suited to the sex of the egg, or even lay an egg of the appropriate sex. Further consideration of my findings and the study of an interesting paper on the same general subject by W. B. Herms (1928) have made me very skeptical of the first hypothesis that the amount of food may affect the sex of the larva. An article by C. P. Clausen (1939) suggests that the second hypothesis is not out of the question.

Assuming that the sex of the wasp is finally determined in the egg, we might otherwise account for the relation between the quantity of stored prey and the sex of the adult wasp by postulating that female larvae with insufficient food fail to become adults, and that male larvae with an excess of food are likewise prevented from reaching maturity. Though it is difficult to imagine a mechanism which would produce this result in the males, and this hypothesis requires that with 50 percent general mortality each female would have to complete eight cells, nevertheless it is pertinent to recall the fact that in 18 out of 44 cells I found no cocoons. This suggests that future studies of the possible effect of food on sex, as well as the sex ratio, should take into account the mortality during development.

Dr. Charles H. Blake, whom I wish to thank for much valuable help and criticism in the course of this study, has suggested another hypothesis, namely, that the sex of the eggs laid by the female in the course of the nesting period might change during this period (probably near the middle) at essentially the same time that the wasp begins to place a different quantity of prey in the cells. This could be readily studied by observational methods; the other hypotheses would be more difficult to test.

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Riley, C. V. 1892. The larger digger-wasp. Insect Life, 4: 248–252, figs. 32–38.

TEXTBOOK OF CLINICAL PARASITOLOGY, by David L. Belding. Pages xxi and 888, 279 figs., 4 col. pls., 7 x 10 inches. 1942. Published by D. Appleton-Century Company, Inc., 35 West 32nd Street, New York City. Price, postpaid, $8.50.

The present war has served to focus attention upon the need for control of parasitic diseases among civilian populations and the armed forces. The publication of Dr. Belding's Textbook of Clinical Parasitology is quite timely. In this book, the author has considered the subject of medical parasitology as a whole. The subject matter includes information on protozoan, helminthic and arthropod parasites of man, their diagnosis, pathology, treatment and control. Teachers of medical parasitology should find this authoritative text excellent for use by their classes. Likewise, physicians in civil practice, the armed forces, public health services and laboratory workers will find it fulfilling many of their practical needs.

The manufacture of the book is excellent and its organization shows painstaking care and foresight. The many diagramatic and semi-diagramatic figures are so constructed and arranged as to present to the reader a complete picture of the life cycle of each parasite, independent of the discussion. It departs from the traditional textbooks of parasitology by its method of presentation as well as the inclusion of chapters on immunity of parasitic infections and the diagnosis of parasitic diseases. Full treatment is accorded common cosmopolitan parasites and those peculiar to the Western Hemisphere. The uncommon or minor parasites are briefly mentioned in small type.

Keys separating major groups of parasites are supplemented, wherever possible, by tabulations of morphological data for comparison. At the end of each chapter is a list of references which are largely limited to publications in English. Citations to literature are carried as footnotes with authors' names and dates. One will find at the close of the discussion an excellent bibliography of books and journals appertaining to parasitology.

The section devoted to arthropods consists of 179 pages of discussion, figures, keys and tables of data. Emphasis is placed upon the biological aspects of parasitic arthropods rather than their morphology. This section thus includes an excellent review of the insects that are directly injurious to man himself. It is especially good because of the numerous diagramatic illustrations. In this part will be found an eight page table summarizing much of the information about arthropods which serve as vectors of human diseases.

This textbook is recommended to entomologists who desire an up-to-date source book on the parasites of man.—W. M. Tidd.

THE IMMATURE STAGES OF SOME MINNESOTA PLECOPTERA

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In recent years at the University of Minnesota attention has been directed toward the study of the immature forms of the orders of aquatic insects. Elkins (1936) began a study of the larvae of Trichoptera and Denning (1937) continued work on that group. Daggy (1938) began the study of the Ephemeroptera of the state, giving special attention to the immature forms of the order. This present study is an endeavor to further the knowledge of another aquatic group, the Plecoptera, found abundantly throughout the various types of streams of Minnesota. Four Plecoptera nymphs definitely associated with previously known species are treated in this study. Included also is a review of the methods of rearing and associating nymphs with adults.

Eleven species of stoneflies were recorded for Minnesota in Needham and Claassen's "Monograph of the Plecoptera or Stoneflies of America North of Mexico." Miscellaneous collecting over the state added to the number of stoneflies in the Minnesota collection of insects. Early in 1939 Dr. T. H. Frison, of the Illinois Natural History Survey, kindly determined these Plecoptera, finding a total of 32 species for the state in the collection. Of the species listed by Needham and Claassen for the state two are not represented in this collection. In addition 9 other species have been collected and determined by the writer. The total of Minnesota species is now 43. Of the 43 species recorded for Minnesota, the nymphs of 26 had been associated with the imago before this work was undertaken; the nymphs of four known species dealt with in this paper bring this number to 30.

A list of the Plecoptera of Minnesota, including those species determined by Frison, two species recorded by Needham and Claassen (1925) and not represented in the Minnesota collection, and species collected and determined by the writer, is as follows:

PTERONARCIDAE
- *Pteronarcys dorsata* (Say)
- *Pteronarcys frigida* Gerstäcker
- *Pteronarcys nobilis* Hagen

TAENIOPTERYGIDAE
- *Taeniopteryx* (*Brachyptera*) *glacialis* (Newport)
- *Taeniopteryx nivalis* (Fitch)
- *Taeniopteryx parvula* Banks
- *Strophopteryx fasciata* (Burmeister)

NEMOURIDAE
- *Nemoura completa* Walker
- *Nemoura rotunda* Claassen
- *Nemoura trispinosa* Claassen
- *Nemoura venosa* Banks

LEUCTRIDAE
- *Leuctra decepta* Claassen
- *Leuctra hamula* Claassen

CAPNIIDAE
- *Capnia opis* (Newman)
- *Allocapnia granulata* (Claassen)
- *Allocapnia minima* (Newport)
- *Allocapnia torontonensis* Ricker

PERLIDAE
- *Atoperla ephyre* (Newman)
- *Perlinella drymo* (Newman)
- *Neoperla clymene* (Newman)
- *Perlesta placida* (Hagen)
- *Acroneuria abnormis* (Newman)
- *Acroneuria internata* (Walker)
- *Acroneuria lycorias* (Newman)
- *Acroneuria ruralis* (Hagen)
- *Neophasganophora capitata* (Pictet)
- *Togoperla media* (Walker)

PERLODIDAE
- *Isogenus frontalis* Newman
- *Hydroperla varians* (Walsh)

CHLOROPERLIDAE
- *Hastaperla brevis* (Banks)
- *Hastaperla orpha* (Frison)
- *Isoperla annecta* (Needham and Claassen)
- *Isoperla bilineata* (Say)
- *Isoperla longiseta* Banks
- *Isoperla marlynia* Needham and Claassen
- *Isoperla montana* (Banks)
- *Isoperla richardsoni* Frison
- *Isoperla signata* (Banks)
- *Isoperla transmarina* (Newman)
- *Isoperla truncata* Frison
- *Isoperla* sp. n. 1
- *Isoperla* sp. n. 2
- *Alloperla imbecilla* (Say)

The division into families is that of Frison (1935).

Various methods of associating nymph with adult have been used with work on stoneflies. Rearing is the most reliable. Smith, one of the pioneers in the work, describes her methods (1913: 203) as follows: "The essential factor in rearing stoneflies, as in many other stream-inhabiting insects, is running water. This is provided by a series of taps in a roof garden aquarium and also in a small artificial pond out of doors. . . . In the artificial pond the nymphs are kept, eight or ten together, in cylindrical cages made of galvanized wire screen with cheese cloth covers. The cages are partially submerged in the current near the taps. With flat stones and bits of water weed in the bottom, and a steady flow of water, the nymphs can live a natural life." Wu (1923) kept and reared his specimens in vials stopped with bolting silk and in small fine wire-screen cylinders placed in the bed of a small spring fed stream. Frison (1929) reared nymphs by keeping them in small tins containing moist leaves until the adults emerged. Frison later (1935) used another technique for rearing, that of putting the nymphs in cages of screen and wood and suspending these, part in water, from a specially built raft anchored in running water.

Claassen (1931) described another method of associating nymph with adult if the nymph is sufficiently mature, that of the recognition of the developing genitalia through the exuviae or with the exuviae "peeled off." Another possibility is that of collecting nymphs, exuviae, and adults at the time of emergence from a locality at which there is only one species emerging at the given time.

REARING TECHNIQUE

The method of rearing used in this work with stoneflies is essentially that used by Denning (1937) rearing Trichoptera and by Daggy (1938) rearing Ephemeroptera. In this method a series of air outlets is connected to a source of compressed air by means of rubber tubing and glass or metal "T" joints. From these outlets air is forced through "alundum" bacteriological filters into the water in small rearing jars about 20 cm. in diameter and 5 to 25 cm. deep. These alundum filters break up the air flow through the water into a stream of fine bubbles. This type of aeration simulates stream conditions quite well as shown by the effectiveness in maintaining individual stonefly nymphs for a long period. A screen cylinder around each jar with a piece of cheesecloth over it furnishes a surface on which emergence can take place and confinement for emerged adults.

A moisture trap and a reducing valve were installed between the main source of compressed air and the lead-off tubing to the apparatus described above. The moisture trap was primarily for the protection of the reducing valve from any water that might get into the compressed air line. The reducing valve made possible the regulation of air flow to the rearing jars. Since the pressure of the main line varied from 15 to 30 pounds per square inch, without a reducing valve difficulty was encountered in regulating the air flow to the filters without an occasional "blowout" with accompanying failure of the aeration of the system and often the loss of valuable specimens from lack of oxygen. The reducing valve used had a meter attached to further facilitate the regulation of the air pressure to the system; a two pound pressure from the reducing valve was found to be most effective.

Such a system has been in operation continuously for sixteen months without mishap. One *Pteronarcys* nymph, collected in August, 1939, emerged in December of the same year, a period of four months in one of these rearing jars. Another *Pteronarcys* nymph, collected in April, 1940, emerged January, 1941; this is a period of nine months.

To maintain a lower than room temperature for the rearing of early spring species, some of the rearing jars were set in running faucet water to about the level of the water in the jars. By this means a temperature of about 10 degrees C. was maintained.

DESCRIPTIONS OF SPECIES REARED

Taeniopteryx (**Brachyptera**) **glacialis** (Newport)

(Figs. 3, 5, 6, 7 and 8)

1848 *Nemoura* (*Brachyptera*) *glacialis* Newport. Proc. Linn. Soc., London 1: 389.
1851 *Nemoura* (*Brachyptera*) *glacialis* Newport. Trans. Linn. Soc., London 20: 450.
1861 *Taeniopterynx glacialis* Hagen. Synopsis of Neuroptera of N. A., p. 36.
1928 *Taeniopteryx glacialis* Claassen. Ann. Ent. Soc. Am. 21: 667.
1929 *Brachyptera glacialis* Frison. Ill. Nat. Hist. Sur. Bull. 18: 373.
1938 *Taeniopteryx glacialis* Ricker. Trans. Roy. Canad. Inst. 22: 131.

Male nymph.—General color brownish black with legs, cerci, wingpads, antennae, and clypeus brownish yellow. Antennae and cerci very long. Length of body 10 mm.; segments in antennae 96 to 100; length of antennae 10 mm.; segments in cerci 64; length of cerci 11 mm.

Head somewhat narrower than pronotum; supra-antennal plates prominent with a slight outcurving above each antenna and a more acute outcurving ahead of each antenna; lateral ocelli just back of a line connecting the anterior margin of the compound eyes; the distance between the lateral ocelli is three times the distance from one to a compound eye; base of the ocellar triangle slightly longer than one of the sides. Color of head dark brown with anterior spot between antennae and posterior part of supra-antennal plates brownish yellow; rugosities present between compound eyes on the caudal portion of the head; dorsal part of enlarged basal segment of each antenna dark brown; the rest of each antenna brownish yellow; antennae about as long as the body.

Pronotum one-third wider than long; posterior and lateral margins only slightly convexed; anterior margin very convex; lateral and anterior margins brownish yellow; disc brown with darker rugosities. Forewing pads very short, their inner margins almost in a straight line with the margin of the mesonotum. Rearwing pads longer and rather acute.

Anterior half of each abdominal segment darker than posterior half. Row of setae present on the posterior of each segment with scattered setae throughout each segment. Dorso-caudal lobe of the 10th segment of the male nymph is dark brown and shows the developing supra-anal plate in more mature specimens. Dark brown embossings show on the lateral aspects of tergites 1 through 8.

Legs brownish yellow, darker toward extremities. Each femur with a notch in its distal margin. Each tibia with two spines on its distal margin. Row of long silky hairs on outer margin of legs. Second tarsal segment longer than first; first and second together as long as the third. Cerci slightly longer than body.

Total ventral aspect yellow except as follows: a brown longitudinal line on each side in the cervical region; a brown blotch on each coxa and on each trochanter; a brown median "T" on the mesosternum, a crosswise line on the metasternum, and an increasingly dark brown color from the 8th abdominal sternite caudally.

Ventral median lobe of 9th abdominal sternite with its sides evenly curved, extending past the end of the abdomen, and with its length two times its width.

DISCUSSION

This was one of the American species of stoneflies omitted from Needham and Claassen's monograph on the Plecoptera of North America and listed under the following statement by Claaassen (1928): "The following are species unable to be recognized because of inadequate descriptions, loss of type material, or inaccessibility to types." The latter phrase probably applied to this species since Ricker (1938) did examine the original cotypes in the British Museum, figured, and redescribed them. The types of this species were from Nova Scotia. No date of collection was mentioned either by Newport in his original description or by Ricker. However, Newport does give the general time of appearance in the following statement (1851: 451), "It appears in the spring (end of March or beginning of April), when the ice becomes honeycombed, and even before then, and at the same time as the preceding species (*Capnia vernalis*), but is not so numerous."

Specimens of this species, determined as such by Frison in 1939, were collected by Daggy and Chalgren from the ice along the Stewart River, Lake County, Minnesota, March 26, 1938. At the same time four nymphs were taken by Daggy from the stream itself. Stewart River is one of the small swift rocky streams that flow into Lake Superior from the north.

Nemoura trispinosa Claassen

(Figs. 4, 9, 10, 11 and 12)

1923 *Nemoura trispinosa* Claassen. Canad. Ent. 55: 289.
1925 *Nemoura trispinosa* Needham and Claassen. Monograph of the Plecoptera of North America, p. 213.

Female nymph.—General color yellowish brown with pronotum darker than abdomen and head darker than pronotum. No gills of any kind evident. Head and pronotum the same width. Length of body 7 mm.; segments of antennae 55; segments of cerci 25; width of head 1.32 mm.; width of pronotum 1.32 mm.; length of pronotum 0.9 mm.; distance between hind ocelli 0.45 mm.; distance from hind ocellus to eye 0.12 mm.

Head almost uniformly dark except for sutures and lateral tubercles. Arms of the epicranial suture somewhat sinuate midway on each. Lateral ocelli barely visible at the curves of the lateral arms. Longitudinal rugosities posterior to the arms of the epicranial suture.

Pronotum with width one and one-third times the length; front margin almost straight; front angles rounded; hind angles very broadly rounded, so much so that the lateral margins and posterior margin make an approximate half circle; a row of stout setae on the anterior and lateral margins, and across the posterior somewhat ahead of the

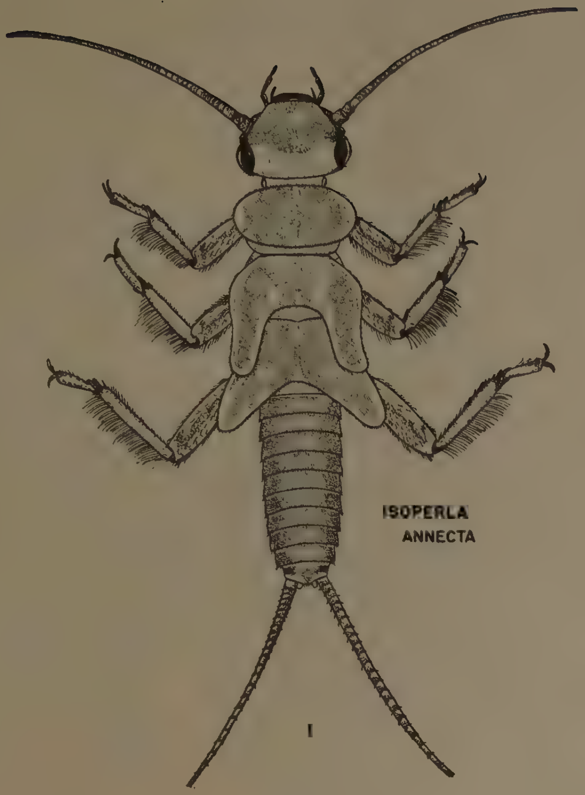

ISOPERLA
ANNECTA
1

Fig. 1. Nymph of *Isoperla annecta*.

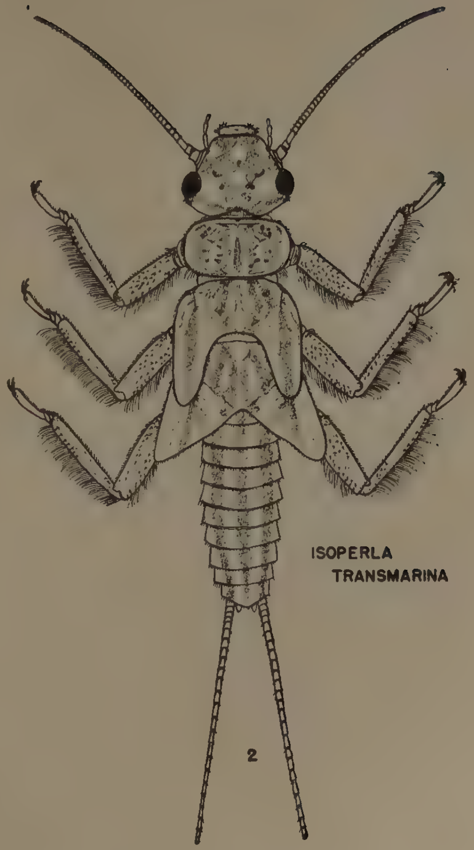

ISOPERLA
TRANSMARINA
2

Fig. 2. Nymph of *Isoperla transmarina*.

margin, being more sparsely scattered across the posterior; four small round dark spots on each half of the pronotum with other shadowy markings about them.

Front wing pads four times as long as broad; hind wing pads four-fifths as long as front ones and one-third wider; anal lobe of hind wing pad about two-thirds the total length of its inner margin. A band of setae across the anterior margins of both mesonotum and metanotum; more numerous at the ends of each band.

Legs dull yellow, covered with fairly stout setae except for naked areas as follows: most of the anterior surface of the fore femora, a longitudinal line on the anterior surface of each of the other femora and of each tibia, the posterior surface of the caudal pair of femora, and a longitudinal line on the ventral surface of each femur and each tibia. No line of silky hairs present on the outer margin. First and second tarsal segments together about as long as the third; second very short.

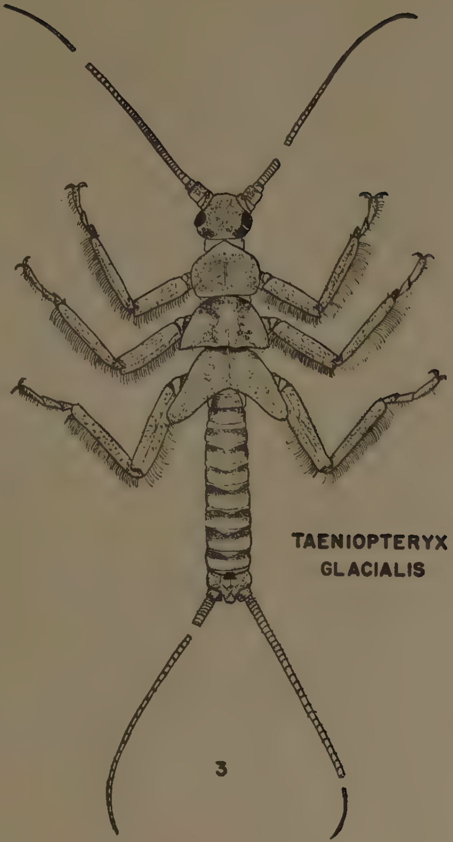
Abdomen yellowish brown above with the anterior margin of each segment lined with dark brown; anterior margins of tergites 5 through 7 slightly emarginate; posterior margin of each tergite lined with setae with some setae scattered over each tergite.

Ventral aspect a dirty white; coxae, in contrast to the legs, a whitish yellow outlined in dark brown; middle and anterior coxae with a subconical shape directed medially, the anterior coxae being more elongate in this direction than the middle ones. Abdominal sternites 1 to 7 membranous; normal in shape to the seventh; seventh sternite somewhat produced and bulged on its posterior margin; eighth sternite narrowed medially; ninth sternite produced on its posterior margin; tenth sternite much narrowed medially.

Mouthparts: Labrum twice as wide as long; anterior margin with fringe of short hairs progressively longer from the center outward. One mandible with three blunt teeth and a convex comb of short stout blunt spines below; the other mandible with six teeth and with a concave comb of short stout spines below. Each maxilla with lacinia terminating in a scoup bordered at the distal margin by four short blunt teeth and at the sides by rows of stiff hairs; galea conical, curved, and not as long as the lacinia; maxillary palpi long and stout. Labrum with glossae slightly longer than paraglossae and about half as wide; labial palpi very stout and short and not extending to the tips of the paraglossae; distal two segments of these palpi together almost egg-shaped.

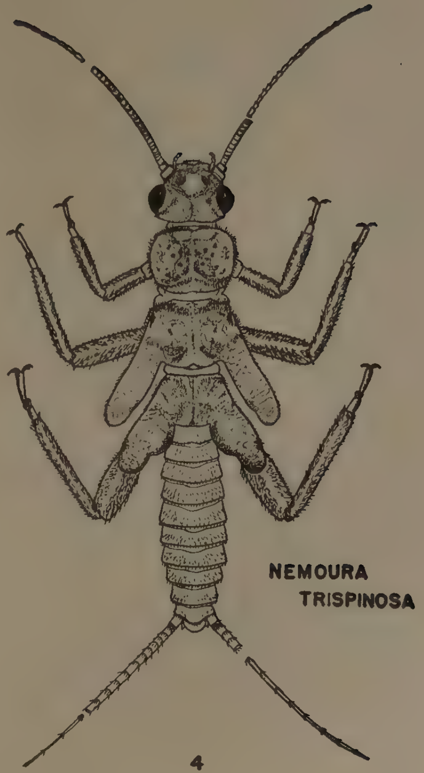
DISCUSSION

This nymph runs to *Nemoura vallicularia* in Claassen's key to the known nymphs of *Nemoura*, from which it differs in the form of mouthparts as figured by Wu (1923: 57; figs. 14, 22, and 26) and pronotal markings as figured by Wu (1923: 53). This nymph of *Nemoura trispinosa* differs from the nymph of *Nemoura dimicki* (Frison 1936: 257) in the uneven distribution of setae on the hind femora and from the nymph of *Nemoura obscura* (Frison 1936: 259) by the presence of stout setae instead


TAENIOPTERYX
GLACIALIS

3

Fig. 3. Nymph of *Taeniopteryx glacialis* (male).


NEMOURA
TRISPINOSA

4

Fig. 4. Nymph of *Nemoura trispinosa* (female).

of silky hairs on the hind femora and by the lack of a "tendency for a light longitudinal stripe on the abdominal tergites." From Seemann's key (1927: 53) to the stonefly nymphs of southern California, *Nemoura biloba* evidently has cervical gills since this is the key character used there for the genus. This nymph of *Nemoura trispinosa* differs from all other descriptions of American *Nemoura* nymphs in the presence of the four teeth of the lacinia and in the curvature of the combs of short stout spines on the mandibles.

A male of this species was taken at a bridge over a small stream midway between Frontenac, Minnesota, and the Mississippi River (a distance of about two miles) on May 30, 1939. The following season three nymphs of this species were taken at the same place, from which two females emerged and of which one was preserved in fluid. These females were *Nemoura trispinosa* as described and figured by Needham and Claassen. From the remaining female nymph the above description was made.

To the writer's knowledge this is the farthest west and also the earliest record for this species. Needham and Claassen recorded this species from Murray Bay, Province of Quebec, July or August, 1878, and from Tompkins Co., New York, June 17–20, 1904, and June 2, 1923. To these records can be added the following Minnesota records: 1 male, near Frontenac, Goodhue Co., May 30, 1939 (P. Harden); 3 nymphs (two of which were reared), Goodhue Co., May 25, 1940 (R. H. Daggy).

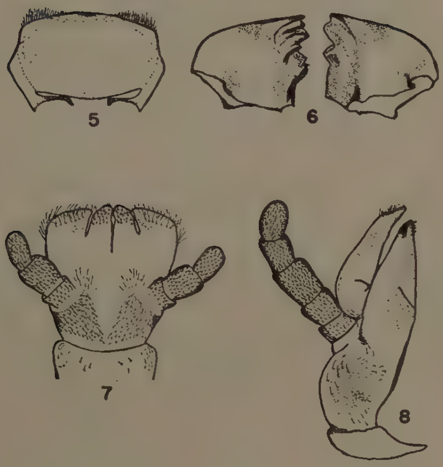
Isoperla annecta (Needham and Claassen)

(Figs. 1, 13, 14, 15, and 16)

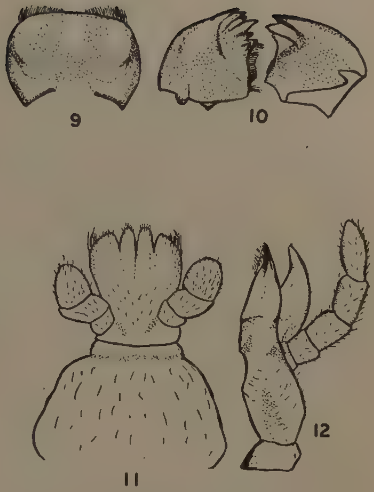
1925 *Clioperla annecta* Needham and Claassen. Plecoptera of North America, p. 140–141.

Nymph.—General body color brown with yellowish white markings. Venter of thorax yellowish white with the venter of the abdomen becoming darker toward the posterior end. No gills present. Length of body of mature nymph 11 to 15 mm.; segments in antennae 50; segments in cerci 28.

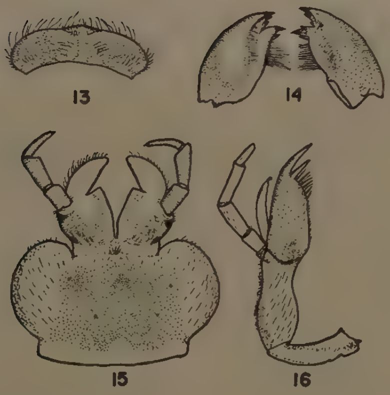
Head with the brown areas anterior to the arms of the epicranial suture darker than those posterior to them. Light areas of the head are: a medium-sized area, squarish, heart-shaped or rounded, in front of the anterior ocellus; a much smaller spot, usually triangular, in the ocellar triangle; a large irregular spot from the inner margin of each compound eye extending medially to the nearest lateral ocellus; a small area on the posterior half of the stem of the epicranial suture; a light



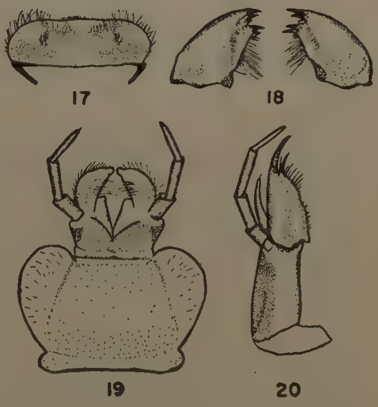
TAENIOPTERYX GLACIALIS



NEMOURA TRISPINOSA



ISOPERLA ANNECTA



ISOPERLA TRANSMARINA

Figs. 5–8. Mouth parts of the nymph of *Taeniopteryx glacialis*. Figs. 9-12. Mouthparts of the nymph of *Nemoura trispinosa*. Figs. 13–16. Mouthparts of the nymph of *Isoperla annecta*. Figs. 17–20. Mouthparts of the nymph of *Isoperla transmarina*.

stripe running inward and downward from the posterior margin of each compound eye. Antennae light at the base and darker toward the distal ends. The three ocelli form an approximate equilateral triangle, somewhat flattened; lateral ocelli slightly ahead of a line connecting the centers of the compound eyes, somewhat farther distant one from another than from one to a compound eye. Mouthparts as figured.

Pronotum oval, about twice as wide as long and with a marginal groove present along the anterior and the posterior margins; a dark line on the extreme lateral margins; a light area along each lateral margin; a median light stripe sometimes continuous and sometimes interrupted by dark spots; a light dot near the center of each half of the pronotum.

Mesonotum and metanotum with light markings; margins of wingpads light, leaving a wide brown central stripe down the center of each wingpad; another narrow short dark line near the lateral margin extending from the base partway out on each wingpad. Legs light with a darker band around the distal end of each femur and one around the proxal end of each tibia; sometimes a longitudinal dorsal dark stripe on the femur is more evident than the distal dark band.

Abdomen uniformly dark brown above; setae line the posterior margin of each segment. Cerci of about 28 segments; medium brown; distal segments many times longer than the proxal ones; a circle of setae on the posterior margin of each segment of the cerci.

The sexes of the nymphs may be distinguished. The female is larger, has a median notch in the posterior border of the eighth sternite, and has the setal fringe interrupted at this notch. The male nymph lacks this notch in the eighth sternite, has the setal fringe continuous at this point, and has the ninth sternite broadly produced behind.

DISCUSSION AND RECORDS

The Minnesota records for this species extend its range much farther west and place its time of emergence much earlier. Needham and Claassen give its records as Clinton Co., New York, June 21, 1910 (C. R. Crosby); and Quebec (Geo. Maheux). In Minnesota this species has been collected as early as April 5 and from that date through May in Hennepin County and in Anoka County, both near St. Paul. Rearings were made in 1935 by L. L. Smith and in 1940 by the writer.

This nymph runs to *Isoperla confusa* in Frison's key to the stonefly nymphs of Illinois (1935: 435) from which it differs in having a greater proportion of brown on its head, pronotum, and wing pads. It runs to *Clioperla similis* in Claassen's key to nymphs (1931: 69) from which it differs in being larger and in having a distinct color pattern on the head, pronotum, mesothorax, and metathorax.

Isoperla transmarina (Newman)

(Figs. 2, 17, 18, 19, 20)

1838 *Chloroperla transmarina* Newman, Ent. Mag., London 5: 499–500.
1839 *Chloroperla transmarina* Newman. Mag. Nat. Hist. N. S. 3: 87.
1908 *Isoperla ventralis* Banks. Psyche 15: 66.
1925 *Isoperla ventralis* Needham and Claassen. Plecoptera of North America, p. 150.
1938 *Isoperla transmarina* Ricker. Trans. Roy. Canad. Inst. 22: 146.

General color dull yellow with light brown markings which are predominantly longitudinal from the head to the extreme end of the abdomen. Length of body 10–12 mm.; segments in antennae 46; segments in cerci 25.

Head yellow with brown markings as follows: a triangle connecting the three ocelli and enclosing in the ocellar area a yellow triangle; areas from the sides of ocellar triangle extending outward to the bases of the antennae and forward to the distal margin of the clypeus, the anterior areas widening near the clypeus so that they become joined, thus enclosing an irregular yellow area in front of the anterior ocellus; a brown spot on each side of the stem of the epicranial suture; a line from the medio-caudal margin of each compound eye inward and downward to the margin of the foramen; a slight darkening toward the posterior margin of the head. Lateral tubercles shining dark brown. Ocellar triangle with the base slightly longer than the sides; lateral ocelli somewhat closer to the compound eyes than to each other and slightly ahead of a line connecting the midpoints of the compound eyes. Mouthparts as figured.

Pronotum over twice as wide as long; anterior and posterior margins nearly straight; lateral margins convex; all angles broadly rounded; marginal groove distinct across the median third of the anterior margin and across the posterior margin; posterior and anterior margins brown; longitudinal brown markings set off a median yellow stripe, and an elongate brown spot laterad of these set off a yellow lateral marginal stripe on each side; setal fringe present on the margin, the setae across the posterior margin being much longer than the others.

Mesonotum and metanotum predominantly yellow with brown longitudinal markings. Forewing pads with a narrow brown line running longitudinally, the line ending just inside the apex. Rearwing pads with longitudinal line forked near the apex.

Legs yellow with the usual row of long silky hairs on the outer margin. Tarsi not darker than the rest of the leg.

Abdomen with three dorsal brown stripes of about equal width running the total length, the median one being narrowed on the caudal segments. Tenth tergite with the posterior margin convex. Cerci with setae on the posterior margin of each segment; one ventral seta of this row on each segment much longer than the others.

DISCUSSION

This is another species listed by Claassen (1928) as one with type lost or inaccessible. Ricker (1938) recently described and figured the female type in the British Museum. The male is that described as *Isoperla ventralis* by Banks (1908) and later by Needham and Claassen (1925).

In his description Banks (1908) described both male and female *Isoperla ventralis*. Needham and Claassen (1925) in their monograph of Plectoptera present figures and description of only the male. Banks replied, concerning a male and a female sent to him recently for comparison with types of *I. ventralis*, "Your male *Isoperla* agrees with the male except that yours is much larger. My specimens are dry, wing length but 8 mm. I cannot find the female I figured; there are three males, one made lectotype by Frison, in alcohol." Thus it is probable that Banks' original association of male and female was incorrect. This idea is supported by the fact that a male, agreeing with Needham and Claassen's description and figure, was taken May 19, 1940, in Chisago County, Minnesota, with a female agreeing with the male in shape and coloring, but being slightly larger. This female agrees with Ricker's redescription of *Isoperla transmarina*. In addition to the pair from Chisago County, spoken of above, several females from the same place were reared. The exuviae from these agree with a nymph taken at Fridley, Minnesota, May 6, 1931, this last nymph being the basis of the above description of this paper.

This nymph runs to *Isoperla bilineata* in Claassen's key to *Isoperla* in his "Plecoptera Nymphs of North America" and to the same species in Frison's key to *Isoperla* in his "Stoneflies or Plecoptera of Illinois." From this species *Isoperla transmarina* can be distinguished by its head pattern lacking the two large white spots on each side of the ocellar triangle, by its wing pad stripes being narrower, and by the abdominal stripes being darker and more sharply outlined.

It is evident that the nymphs of *Isoperla transmarina* inhabit medium to large rivers. The nymphs from Chisago County were taken from leaves and trash washed against a tree fallen into the North Branch River. The male and female were taken from a tree nearby.

DISTRIBUTION

This species has a northeastern distribution in North America. Newman's type specimen was, according to his original description (1838), from Trenton Falls, Canada, (possibly the region of Trenton Junction, Ontario). Banks' types of *Isoperla ventralis* are from Grand Lake, Newfoundland, taken July 28, 1906. The Minnesota records include, besides those already mentioned from Chisago County, one female taken in Winona County, May 19, 1940.

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NEOPARACLETUS CARICIS, A NEW GENUS AND SPECIES OF APHIDAE (HOMOPTERA)

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Neoparacletus, new genus[1]

Antennae of six segments. Secondary sensoria in alate form numerous, small and oval. Absent in apterous form. Antennae with only a few short hairs. Apterous form with eyes composed of three facets; with occasional specimens having intermediate eyes. Cornicles absent. Cauda broadly conical, bearing numerous short hairs. Anal plate large, narrow, and bearing many short hairs. Each thoracic segment with a pair of well developed wax glands. Fore wings with the media simple; hind wings with both media and cubitus. Forms robust and live in close association with ants on the roots of *Carex*. Alatae rare. Sexuals unknown.

Genotype and only included species: *Neoparacletus caricis*, new species.

This genus is closely related to *Paracletus* by the number of segments in the antennae, the type of secondary sensoria, as well as in wing venation. It differs from *Paracletus* in the type of cauda and anal plate which in the later genus are rounded or luinar; while in *Neoparacletus* the cauda is elongated and approaches the elongated-conical caudae found in many species of the tribe *Aphidini*. The anal plate is elongated, narrow, with the tip rounded.

It also differs from *Paracletus* by having a pair of well developed wax glands on each thoracic segment, while *Paracletus* is in part characterized by having only a single centrally located wax gland on the mesothorax.

Neoparacletus caricis, n. sp.

Alate viviparous female.—Average length of body from vertex to anal plate 2.50 mm. Head black, pulverulent. Width of head through the compound eyes .50 mm. Eyes dark with ocular tubercles. Antennae of six segments: black in color. Length of antennal segments: II, .11 mm.; III, .40 mm.; IV, .20 mm.; V, .19 mm.; .14 mm., plus .03 mm. Sensoria on antennae distributed as follows: III, 53 to 65; IV, 22 to 26; V, 21 to 25; VI, 1 to 3. Rostrum obtuse, reaching slightly beyond third pair of coxae.

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[1] The writer wishes to express his thanks to A. C. Maxson, of the Great Western Sugar Company, Longmont, Colorado, for his opinion concerning this form.

Thorax black, pulverulent. Prothorax yellowish. Each thoracic segment with a pair of well developed wax glands. Fore wings with the media simple. All veins failing to reach margin of wing. Hind wings with media and cubitous present. Legs black. Hind tibiae 1.10 mm.; tarsi .30 mm.

Abdomen sordid yellow, with conspicuous threads of wax along median line. First six segments of abdomen each with a pair of well developed wax glands. Cornicles absent. Cauda broadly conical, bearing numerous short hairs. Length of cauda .14 mm. Anal plate large, elongated and narrow, with the tip rounded and bearing numerous short hairs. The anal plate extends a little beyond the tip of the cauda.

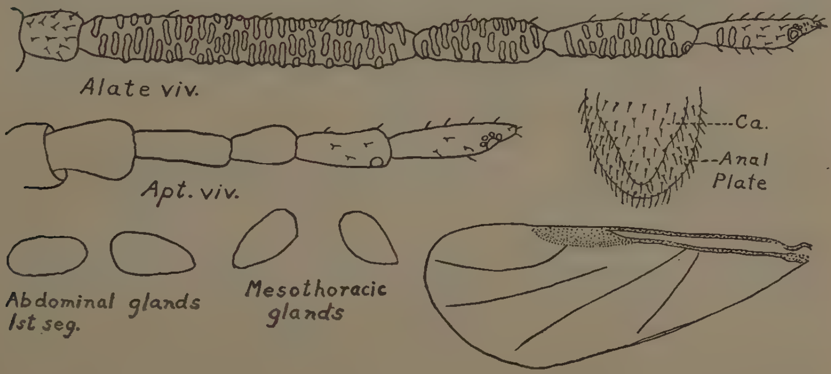

Fig. 1. *Neoparacletus caricis,* a new genus and species of Aphidae.

Apterous viviparous female.—Prevailing color milk white, with some individuals showing a tinge of light brown. Entire body covered with pulverulence. Length of body from vertex to tip of anal plate 2.90 to 3.80 mm. Head dusky. Eyes composed of three facets with some having intermediate eyes. Antennae composed of six segments. Early summer forms have antennae of only five segments. Antennae dusky in color. Length of antennal segments as follows: II, .11 mm.; III, .13 to .16 mm.; IV, .10 to .19 mm.; V, .13 to .15 mm.; VI, .15 to .17 mm., plus .03 mm. Secondary sensoria absent. Hairs on antennae sparse. Legs light brown to dusky in color. Rostrum obtuse and reaching well beyond the third pair of coxae. Cornicles absent. Cauda and anal plate dusky; in structure the same as alate. Length of cauda, .15 mm.

Host plant and feeding habits: This large new species was found feeding in large colonies on the roots of *Carex* sp. Alate viviparous females occur only in the fall, the summer generations being entirely apterous.

Type locality: Milwaukee, Wisconsin (National Home Grounds). *Holotype* alate viviparous female and *Morphotype* apterous viviparous female collected on Sept. 26, 1940. *Paratypes* collected on the following dates at same locality as types:

Aug. 22, 30, 31, 1939; June 25, July 6, 10, Aug. 13, 14, Sept. 26, 29, 1940 (Strom Coll.). Holotype deposited in the U. S. National Museum. Paratypes in the writer's collection and that of A. C. Maxson.

Toxoptera viridi-rubra Gill. and Pal.

This reddish brown species was collected by the writer in Wisconsin (Milwaukee Co.) on *Carex* on Nov. 4, 1936. Both apterous viviparous females and ovipara were found at this time. Two collections were also made by the writer at Grand Haven, Michigan, on June 8 and 12, 1936. This species has previously been recorded only from Colorado.

Thripsaphis verrucosa Gillette

Thripsaphis verrucosa Gill., Can. Ent., Vol. 49, p. 194, 1917.
Thripsaphis caricicola Swain, Ent. News, Vol. 29, p. 367, Dec., 1918, *New synonomy.*

This species has been recorded from California, Colorado and Illinois. It is easily recognized by having a peculiar projection from the vertex. In Wisconsin, the writer has collected it only in Milwaukee County, in a small *Carex* habitat at the National Home Grounds. However, whenever it is found it occurs in large numbers. All forms have been collected in Wisconsin.

The above synonymy is based on a study of cotypic slides of *Thripsaphis caricicola* Swain, kindly loaned to the writer by Dr. I. McCracken and specimens of *T. verrucosa* Gill. collected in Wisconsin. Hottes and Frison,[2] in their description of the apterous viviparous female of this species state that the antennae are without secondary sensoria. All specimens of this form examined by the writer show three small sensoria near the distal portion of antennal 111. These sensoria are very small and not readily seen. Cotypic specimens of *T. caricicola* from California and a large series of *T. verrucosa* collected in Wisconsin, all had two small sensoria near the distal end of antennal 111.

The male of this species is apterous and pinkish in color.

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[2] Hottes, F. C., and T. H. Frison, 1931. The Plant lice, or Aphiidae, of Illinois. Bull. Ill. State Nat. Hist. Survey, 19 (3): 121–447; 336 figs.

THE NESTING HABITS OF POLISTES WASPS AS A FACTOR IN TAXONOMY

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The suggestion is made by Dr. Robert Bugbee, in an interesting paper on *Polistes fuscatus* (Ann. Ent. Soc. Amer. 29: 614–616, 1936), that the nesting habits of *Polistes* wasps may be considered as another character for use in working out the phylogeny as well as the taxonomy of these wasps. He further states that a few clues in this line are now at hand, and more should be gathered since "the study of this aspect of behavior offers many interesting problems and angles." His remarks have still greater significance inasmuch as a study of the genus *Polistes* offers baffling difficulties to the taxonomist. Therefore any additional clues that their behavior can supply may in part answer the questions perplexing the taxonomist; or they may at least show the directions in which the various members of the genus are moving, psychologically.

In this region, four species of *Polistes* abound, of which only three, *P. pallipes*, *P. variatus* and *P. rubiginosus*, will be discussed in this paper. This is because these three species are given the status of varieties or color forms of the typical *P. fuscatus* by Dr. Joseph Bequaert in his important contribution on the Taxonomy of *Polistes* Wasps (Journ. N. Y. Ent. Soc. 48: 1–31, 1940).[1] The fourth local species which I have studied will not be discussed here because it is not so closely akin to the aforementioned three, and is placed in another category by Dr. Bequaert. These are only three of the eighteen which are designated as varieties or color forms of *P. fuscatus*. Apparently giving them this position was the only thing to do because specimens collected from a wide area show an intergradation of color, and also because of a lack of structural differences among the members of the *fuscatus* group. Dr. Bequaert almost despairs when he states that "North American Polistes are quite variable in the extent, arrangement and shade of color markings, and in *P. fuscatus* the color seems to run riot and defy any attempt at rational analysis."

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[1] For the sake of consistency, I shall refer to them as species rather than varieties or color forms.

There are, however, two important features in our local *Polistes* fauna which help to overcome the difficulties which Dr. Bequaert has met. The first is the fact that, in spite of the intergradations of color in material from wide areas, our three species here are so distinct in color or pattern as to make them easily recognizable to the casual observer, even when the wasps are on the wing; *rubiginosus* is of a solid bright, brick-red color, *variatus* has yellow bands on a brown body, and *pallipes* has a somber black-brown body with slight traces of ferrugineous blotches. The second feature is that, even though there are insufficient structural differences to give specific rank to each one, there are psychological differences which culminate in distinctive patterns of nest-building and brood-care. These are the clues, as it were, which may indicate that they have traveled as offshoots from the parent stock and also the direction in which they are moving.

This brings us to the point of reviewing briefly the distinctive behavior patterns of these three species.

1. While all three species live in the same areas, each occupies a habitat of its own. *P. pallipes* builds its nests in well-lighted parts of man-made structures, under overhanging rocks and rarely in thickly matted vegetation. *P. variatus* nests in hollow places in the ground, under rocks on the ground where they may excavate a depression, in tin cans or old pans on rubbish dumps. *P. rubiginosus* always nests in dark places, in hollow trees or in the space between the outer and inner walls of old buildings (Bull. Brook. Ent. Soc. 26: 111–118, 1931, and Ecology 10: 191–200, 1929).

2. There is murderous antagonism between the species; each one has traveled so far in its own divergent way from the parent stock that they even recognize one another as enemies (Journ. Comp. Psychol. 10: 267–286, 1930, and 27: 259–269, 1939). Dr. Bequaert suggests that one possible way to solve the species problem in *Polistes* is by a study of the heredity in color pattern by crossing them, but this antagonistic attitude precludes that. In nature also, crossing is not likely to occur for the additional reason that, even though they live in the same area, each occupies a different niche in it and they do not mingle. At least I am sure of this for *P. rubiginosus*, in which species mating occurs near the nest (Ent. News 40: 7–13, 1929).

3. Pleometrosis occurs in *P. rubiginosus*, nests being founded by few or many queens, sometimes as many as seventeen (Psyche 38: 129–144, 1931), while in *P. pallipes* and *P. variatus* each nest is founded by but one queen (1 c., footnote, p. 134. Additional data in course of publication).

4. Even though nests of *pallipes* and *variatus* are founded by single queens and begun at the same time of the year, the nests of *variatus* are much larger than those of *pallipes* before the end of summer (paper in course of publication).

5. When the places of hibernation of the three species are considered, some differences are found. *P. rubiginosis* has been found hibernating only in hollow logs, while *pallipes* and *variatus* have been found sheltered for the winter behind closed shutters or other nooks about buildings.

6. *P. rubiginosus* which build in close, dark places, is the only one of the three which has guards at the knot-hole entrance to the nest, and I have actually seen them keep out intruders. But the primary purpose of these doormen is to ventilate the nest in its close quarters. The others, which build in light, airy places, do not need this type of specialization, and they do not have it.

7. Under normal conditions, all three species make round nests with the pedicel in the center. These they attach to horizontal surfaces, hence the nests also hang in a horizontal position. However, *P. pallipes* sometimes attempts to hang a nest horizontally on a vertical wall instead of on the adjacent ceiling. When this is done, the nest seldom attains full size, and is often abandoned early in its development. One sometimes sees numerous dabs of paper-pulp plastered on a vertical wall where a stupid queen has made many attempts at building a pedicel but finally gave up the project. The item of interest in this connection is that when this condition occurs one usually finds several such nests in one place as though they had been produced by a certain "strain" living in that area. My point in citing this behavior is to show that certain *pallipes* have broken away from the customary habit of their own kind and are doing this one thing differently. The wisdom of this digression need not be discussed here; it suffices to say that it was needless, since ample ceiling space was near by. However, this trait seems to have become fixed to some degree in their heredity, for whenever I find this condition in a barn or a shed, I usually find similarly distorted nests from previous years nearby. It is true that certain *Polistes* wasps in the tropics place their nests on vertical walls, but they build the pedicel at the top and let the nest hang vertically in a pear-like form.

The behavior patterns enumerated above would give *pallipes*, *variatus* and *rubiginosus* the status of physiological races, according to taxonomists. Bequaert himself recognizes this status, for he says (l. c. p. 6) that "perhaps we are dealing here with ecological, physiological or even behavioristic races." It seems, therefore, that the conditions which we view in the above three categories are somewhat midway between the lower categories of Bequaert and the status of full-fledged species, and that these distinct behavorial adaptations bring them well on the road to becoming true species.[2] Today, it is true, they offer nothing tangible for the taxonomist to work upon, but this is evidently due to the fact that structural modifications have not yet caught up with the psychical advances which are driving the offshoots of a simple parent stock in three directions. Persistence in these separate directions and the mutual antagonisms will doubtless eventually intensify the differences already evident. That psychical changes should occur under our eyes today is no more strange than that they have occurred in ages past. At one time, members of the genus *Polistes* were few and of simple habit. Diversification has brought them to the various states we see today. But all this merely points to the probability that organisms have first to change some essential item in their mode of living before a structural modification can gain a foothold. We have in these three groups evidence that the physical form remains stable while the mental activities change; behavior is much more plastic than structure, and in the race of evolution behavior may be, chronologically speaking, miles ahead of morphological change. This is held to be true, not so much by the laboratory student as by persons who spend much time in the field. The late Dr. W. M. Wheeler was one who studied insects in their native surroundings. I quote a paragraph from his "On Instincts" (Essays in Philosophical Biology, p. 49, 1939):

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[2] It seems that this study fulfills the prediction of Dr. A. E. Emerson, who says in a recent review of Huxley's book, "The New Systematics," "Inasmuch as the species is a stage in the evolutionary process, we should expect to find stages leading up to the species in some instances. Such discoveries help in understanding the essential processes of speciation, and help to clarify the dymanic nature of the species."

"I can only state * * * my conviction that structure is after all the visible, highly mechanized end-stage of function, and that our inability to detect the inheritance of an acquired character is probably due to the fact that its visible appearance is preceded in phylogeny by a period of many generations during which it is inherited only as a function associated with alterations of structure too subtle to be revealed by our present very crude methods of observations and experiment. Inheritance of alternative characters in definite Mendelian ratios would therefore be merely the method of inheritance of stereotyped end-products of a long evolution and would not represent the actual phylogenetic method of development of such characters."

INSECTOS DO BRASIL, 3.° TOMO, HOMÓPTEROS, by A. DA COSTA LIMA, pp. 1–327, 267 figs., 1942. Published by the Escola Nacional de Agronomia in its Série Didática, N. 4.

This excellent volume is the fourth of the general work, Insectos do Brasil, being published by Prof. A. da Costa Lima, Professor of Entomology in the National School of Agriculture. When completed this work will be the first general work on tropical entomology in the Portuguese language that can be used in the higher schools of Brazil. Prof. Costa Lima has written many articles on tropical Homoptera, particularly on scale insects, so that volume 4 is in his own field of scientific work.

In the more than three hundred pages of text no attempt has been made to give lists or keys to species or even to genera. The author has had to choose material carefully and has given us a volume that brings together what is known on structure, life history and economic relations of the Homoptera. Even in his own group, the Coccoidea, keys run only to subfamilies and to tribes. The illustrations are numerous (267 figures) and well done. We see the artists signatures, C. Lacerda, Jm. F. Toledo and De Costa Lima. The press work is good and the quality of paper of the best. We regret the lack of space in the Annals for a more detailed outline of this work.—C. H. K.

SOME OBSERVATIONS ON REARING ODONATA IN THE LABORATORY

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The difficulties of rearing Odonata under laboratory conditions have long prevented the use of a desirable type of material in both teaching and research. Some half dozen other insect orders have attained important places in research largely because of the comparative ease with which they could be bred and reared under experimental conditions. Morphology, embryology, physiology, and genetics have profited enormously.

Almost untouched, however, are certain fundamental conditions which are prominent in the Hemimetabola, and especially in such insects as involve both aquatic and terrestrial environments in a single life cycle. Of these orders the Odonata is outstanding. The late Dr. R. J. Tillyard wrote his "Biology of Dragonflies" (8) in the expressed hope, unfortunately not realized, that it might stimulate an interest in bringing odonate materials into more general use. Undoubtedly the obstacles in the way of using the Odonata are greater, though not insurmountable, than in many other groups, but the problems afforded by their study are attractive and fundamental. Awaiting attack are further investigations on growth, involving both morphology and physiology; the course and causes of transformation; the presence and activities of endocrines as yet unknown; the cytology of metamorphosing tissue cells as well as that of germ cells; and the accurate determination of many life histories. Granted that some of these problems have been investigated in the Metabola it is still true that they may be seen more clearly and perhaps from a better phylogenetic viewpoint in the less complex forms.

It is these facts that have prompted the writer to add some of his own experiences in rearing Odonata to the records available, mainly those of Needham, Calvert (1), (2), (3), Grieve, and a few others. All but one of these has been concerned chiefly with larval stages and have little to say of rearing adults in captivity.

The aquatic environment of the larva and the terrestrial requirements upon the adult are so far separated that rearing techniques must follow distinct methods.

REARING LARVAE

The rearing of nymphs in their natural habitats during summer has been extensively covered by Professor Needham (5), (6), (7), and others. When the work is done in the laboratory and is carried throughout the year modified aquarium methods must be used. In addition to green plants for chemical balance and mechanical support, isolation of the individuals must be effected by screens, separate aquaria or finger bowls to prevent constant losses through cannibalism.

While the problem of feeding larvae is not a difficult one the writer has found certain variations an advantage in the cases of such Anisoptera as *Anax*, *Aeshna*, *Tramea*, *Sympetrum*, etc. Bits of frog's liver or other soft tissue (mature vertebrate muscle and connective tissue seem either too tough or too concentrated) may be substituted for the usual meal-worms or insect larvae carried in cultures as a food supply. Such food is always at hand in any laboratory and seems well adapted to the nourishment and growth of nymphs of medium and large size at least. From 1937 to 1940 numbers of specimens varying from a dozen to over fifty at a time have been thus experimentally fed and carried along. Two or three feedings a week were given. The larvae, when not parasitized, always ate voraciously, and molted at apparently normal intervals for the season. In order to insure the proper amount of food and to prevent the fouling of the aquaria most of the feeding was done by hand. A bit of liver was held in forceps before the larva and if the latter did not respond promptly it was picked up between thumb and finger, when defensive thrusts of the labium resulted in the seizure of the food. The insect was replaced in the water where it continued to rapidly ingest.

This method has the advantages of certainty respecting the kind of food taken, the amount ingested at one feeding, and the number of feedings necessary under varying conditions. Further, it makes possible, in specimens with semi-transparent bodies, investigation of the progress of food down the alimentary canal and of digestion in each of its divisions. This is particularly true in freshly molted specimens and in such genera as *Tramea*. These individuals gorge themselves rapidly, filling the crop quickly, while the passage of the food to the ventriculus and intestine proceeds gradually over a period of many hours or even two to three days. Such observations have been made by the writer on several genera and in various stages. Opportunity is here given, also, for studying such fairly constant movements of portions of the digestive tract as peristalsis and the oscillation of the ampulla.

Observations of especial interest may be made during the period immediately preceding emergence, the reorganization of the labial muscles gradually making feeding impossible, and allowing for the complete emptying of the alimentary canal.

REARING ADULTS

The aerial habit and extreme activity of adult Odonata usually make captivity fatal. Miss Grieve's account of the rearing of *Ischnura verticalis* (4) is the only one known to the writer. As this species is one of the smaller damselflies the problem of captivity in fairly normal habitat conditions can be met by the use of sizable aquaria covered by screened enclosures and supporting adequate vegetation. While such a method might possibly be adapted to smaller Libellulids, no records are known. The Aeshnids, however, are large, swift of flight, and long of range. Further they are voracious feeders and have never been known to capture living prey placed in their cages. Their adult period is, also, weeks in length. Thus the methods used with the smaller weaker fliers are not applicable.

The age of specimens taken in the field cannot be determined with accuracy, and if studies are to be made upon the development of glands and their physiological relations to reproduction, longevity and other functional conditions, individuals must be reared from emergence to reproductive maturity at least and possibly to normal death.

To attain these results the writer has collected large numbers of nymphs during the summer and carried them through to emergence. Each morning the tenerals which have emerged during the night, normally between eleven P. M. and two A. M., are placed in individual glass battery or other jars of similar size and covered with wire screens of coarse mesh (¼″). These cages are placed in a north window with plenty of fresh air. Here the dragonflies hang without attempt at flight as the distended body hardens. In forms like *Anax* and *Aeshna* no food is taken for at least two days due to the gas-inflated gut. The period is shorter in smaller species.

On the third day each Aeshnid individual is offered soft living or fresh food passed through the screen on the tips of forceps, but no effort is made to force the insect to eat. Very soft-bodied flies or jelly-like muscles scraped from the bodies of large nymphs are used. As the days pass larger and heavier flies, etc., are given, and in case the captive refuses to accept the food readily it is held by the wings and the food introduced into its mouth as it bites at its captor. Once the food juices are tasted mastication continues and the insect may again be hung from the wire roof of its cage. But one feeding a day is given at first but with increasing age the number is increased to two or three, each being equivalent to one or two medium sized flies.

The motions of the mouth parts are of interest. When closely observed under a Greenough binocular microscope equipped with 32 mm. objectives the actions of individual parts may be followed. The labium provides a basket or trough within which the food is rotated (1) by the alternating grasping actions of the mandibles and the maxillae, (2) by slight forward thrusts of the labium, and (3) by the rotating manipulations of the bristle-covered hypopharynx. The spines on the lateral divisions of the labium, together with the finer bristles along the labial margins, prevent the masticated food from escaping. Thus the shearing action of the mandibles and maxillae reduce the fly or other prey to a soft pulpy ball which decreases steadily in size as it rotates, and until the last small remnant is swallowed.

By this method of hand feeding, adults have been kept alive and apparently normal for more than a month. One specimen's food consumption was carefully recorded by the writer. In twenty-eight days it ate some seventy flies (*Musca*, etc.) in addition to the scraped muscles of a dozen large Anax nymphs. Its excreta, after drying in a vial for some weeks, weighed .207 grams.

There was, however, considerable variation in the survival ages of different specimens. Some lived but a day or two; many died at about fifteen to sixteen days, those surviving beyond this amounting to about 30 per cent. At times death was due to neglect of proper feeding, but at others the causes were not clear. Over-feeding or the eating of too much heavy chitin often seemed the cause. In the latter case dissection exposed masses of chitin clogging the entrance to the ventriculus, and it was this discovery which led to the feeding of muscle scrapings from nymphs or of other pulpy food during the first few days after emergence, and at all times to the avoidance of insects having heavy skeletons. The type of food also played a part. *Anax* and *Aeshna* refused such flies as *Callifera* and *Lucilia*, while eating *Musca* greedily

Temperature conditions seem important; many deaths occurred on hot days, especially if plenty of fresh air was not provided. At such times, also, some individuals became so active as to beat themselves to death.

While the death rate seemed markedly affected by the conditions just mentioned, there were, also, differences produced by more fundamental nutritional and physiological conditions; some died within a few days while others survived for several weeks. Probably some were parasitized, but it would seem possible that the nutritional conditions affecting the life of the last instar might be carried over into the imago, determining its physiological state and causing variation in physical stamina.

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(2) **Calvert, Philip P. 1929.** "Different rates of growth among animals with special reference to the Odonata." Proc. Am. Phil. Soc. Vol. LXVIII, pp. 227–274.

(3) **Calvert, Philip P.** 1934. "Rates of Growth, Larval Development, and Seasonal Distribution of the Dragonflies of the Genus Anax (Odonata)". Proc. Am. Phil. Soc. Vol. 73. pp. 1–70.

(4) **Grieve, Evelyn G.** 1937. "Culture Methods for the Damselfly, Ischnura Verticalis." pp. 268–270 in Galstoff, Lutz, Welch, & Needhan's "Culture Methods for Invertebrate Animals." Comstock Publishing Co.

(5) **Needham, James G.** 1899. "Directions for Collecting and Rearing Dragonflies, Stone flies, and May flies." Bull. U. S. Nat. Mus. No. 39 Part O,

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(7) **Needham, James G.,** and **Heywood, Hortense B.** 1929. "A handbook of the dragonflies of North America," Chas. C. Thomas. (Chapter on "Collecting and Rearing.")

(8) **Tillyard, R. J.** 1917. "The Biology of Dragonflies." Cambridge University Press.

ON THE STOMODAEAL NERVOUS SYSTEM OF INSECTS[1]

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College Park, Maryland

The term, stomodaeal nervous system, is used by Snodgrass (1935) as the name for the system centering in the stomodaeal ganglia and having nerve fibers extending to the stomodaeal part of the alimentary tract. During the last hundred years, several different names have been applied, principally sympathetic, visceral, pharyngeal, and stomatogastric. Although the last word is widely used today, it is not sufficiently inclusive since various parts of the stomodaeum such as the salivary glands and aorta are innervated by fibers extending from the ganglionic centers of the stomodaeal nervous system. In addition the alimentary tract is innervated by a system of nerves emanating from the posterior abdominal ganglion of the ventral nerve chain. Furthermore the term, stomodaeal, first proposed by Janet (1899), seems especially fitting for this system of nerves and ganglia because the ganglionic centers arise during embryonic development by ingrowths from the dorsal wall of the stomodaeum.

Müller (1828) first offered the analogy with the sympathetic nervous system of vertebrates which is still retained in a modified form. The vertebrate sympathetic nervous system is a part of the autonomic nervous system which innervates various glands, the heart and blood vessels, and certain viscera as does the stomodaeal nervous system in insects. Here the analogy ends, however, for regulation of the breathing mechanism of vertebrates is an important function of the autonomic nervous system; while in insects the spiracles and tracheae receive nerve fibers directly from the ventral nerve cord. The vertebrate heart is innervated exclusively by fibers from the autonomic nervous system, but nervous control of the hexapod aorta is maintained through connections from both the stomodaeal system and the ventral nerve cord.

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[1] The subject matter of this paper formed part of a thesis submitted to the faculty of the Graduate School of the University of Maryland in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Grateful acknowledgment is made of the help of Mr. Robert E. Snodgrass, who directed the work, and Dr. Ernest N. Cory, Head, Department of Entomology.

The variation in number and position of the nerves and ganglia of the stomodaeal nervous system makes it somewhat useless to describe any typical arrangement although there are a few fairly constant features such as the frontal ganglion and the recurrent nerve. Further generalization is complicated by the terminology which has become more confusing with each addition to the literature. Existent information with one or two exceptions has been published incidentally along with studies of the central nervous system, corpora allata, histology of the brain, and embryology. In this connection the papers of Blanchard (1858), Janet (1899), de Sinéty (1899), Bordas (1900), Holste (1910), Nabert (1913), and de Lerma (1933, 1937) should be mentioned as the most outstanding.[2] Recent interest in the subject of insect endocrinology has been intensified by much experimental work but has been accompanied by a sort of lag in morphological investigations.

THE STOMODAEAL NERVOUS SYSTEM OF A GRASSHOPPER

In the literature are found descriptions of the stomodaeal nervous system of several members of the order Orthoptera. In the present paper the stomodaeal nervous system of the grasshopper, *Schistocerca americana* (Drury) is described not because it is necessarily typical of this order but because it can be adapted to a clarification of the nomenclature and because it will serve as a starting point for an explanation of the numerous differences in arrangement which exist.

In *Schistocerca* (fig. 1) the frontal ganglion (Fr Gng) lies just above the pharynx in front of and slightly below the brain with which it is connected by the frontal ganglion connectives (Fr Gng Con). These bilateral connectives were called the arched nerves in the early literature. The recurrent nerve (R Nv), which has been termed the sympathetic, stomatogastric, and gastric nerve, extends posteriorly from the frontal ganglion, and following the dorsal wall of the pharynx and oesophagus runs under the brain and into the occipital ganglion slightly caudad of the brain. The occipital ganglion (Oc Gng) has been named the hypocerebral, the pharyngeal, the oesophageal, the subcerebral, and the anterior visceral ganglion by various authors. The word, occipital, should be restricted to the median ganglion which is penetrated anteriorly by the fibers of the recurrent nerve and which in *Schistocerca* and many other insects appears as a swelling of the recurrent nerve.

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[2] Since this paper was submitted for publication, two related papers have become available and should be added to this list. They are:

Hanström, B. 1940. Inkretorische Organe, Sinnesorgane und Nervensystem des Kopfes einiger niederer Insektenordnungen. Kungl. Sv. Vetenskapsakad. Handl. (3rd Series) Bd. 18, no. 8: 1–265, figs. 1–239.

Nesbitt, H. H. J. 1941. A comparative morphological study of the nervous system of the Orthoptera and related orders. Ann. Ent. Soc. Amer. 34: 51–81, pls. 1–7.

Branching dorsally from the occipital ganglion are the paired corpora cardiaca (C Cd) each of which is joined to the brain by a short nerve. These structures have been called the anterior oesophageal or pharyngeal ganglia. They are called pharyngeal bodies by de Lerma

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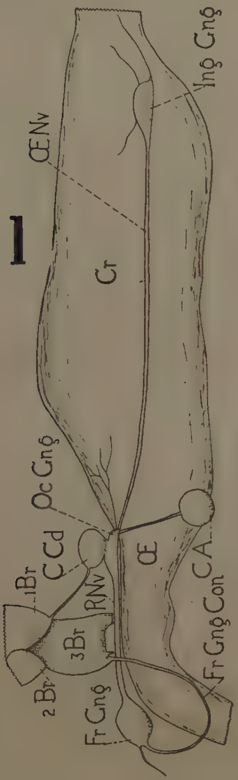
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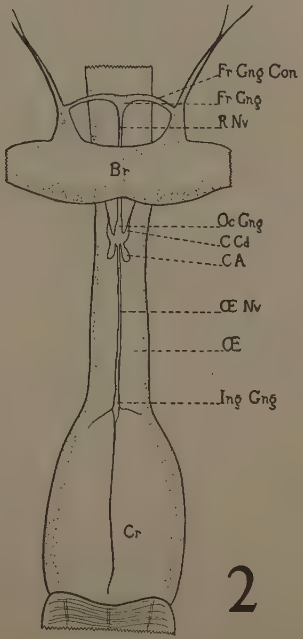
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Fig. 1. Lateral view of Stomodaeal Nervous System of *Schistocerca americana* (Drury).

Fig. 2. Dorsal view of Stomodaeal Nervous System of a Dragonfly Naiad (unidentified); aorta removed.

EXPLANATION OF THE ABBREVIATIONS USED:

Ao—aorta
Ant—antennal
Br—brain
1Br—protocerebrum
2Br—deutocerebrum
3Br—tritocerebrum
CA—corpus allatum
CCd—corpus cardiacum
Coe—circumoesophageal
Con—connective
Cr—crop
Fr—frontal
Gng—ganglion

Ing—ingluvial
Lm—labral
M—muscle
Nv—nerve
Oc—occipital
OE—oesophagus, oesophageal
Op—optic
Phy—pharynx, pharyngeal
Pmp—pump
R—recurrent
Soe—suboesophageal
Vent—ventriculus

(1933, 1937) who has presented histological evidence of their glandular nature in the oriental cockroach and other insects. The term corpora cardiaca was originated by Pflugfelder (1937A) whose studies on the phasmid, *Dixippus*, have not yet furnished experimental proof of the secretory nature of these bodies. Pfeiffer (1939) suggests the possibility that a hormone secreted by the corpora cardiaca may be associated with the molting mechanism in the grasshopper, *Melanoplus*.

In *Schistocerca* the paired corpora allata (C A) are located below and slightly posterior to the occipital ganglion with which they are connected by short nerves. Extensive histological, embryological, and experimental investigations have established the fact that the corpora allata are glands of internal secretion, but a discussion of this work is outside the scope of this paper. Suffice it to say that hormones secreted by the corpora allata probably have different functions in different species of insects; that there is no positive proof that the corpora allata are the source of the hormone which influences molting; that there is experimental evidence to show that in some insects a hormone secreted by the corpora allata controls metamorphosis; and that by removal of the corpora allata from certain hemimetabolous insects it has been demonstrated that they are the source of a hormone necessary for normal reproduction.

Extending posteriorly from the occipital ganglion in *Schistocerca* there are two pairs of nerves. One pair soon branches along the dorsolateral oesophageal wall and the anterior wall of the crop and sends fibers to the aorta. The other pair of nerves, the oesophageal nerves (OE Nv), run along the lateral walls of the oesophagus and crop. In many insects there is a single oesophageal nerve, and whether paired or unpaired the same nerve has been called the pharyngeal, the ventricular, the gastric, the stomatogastric, the vagus, and the sympathetic nerve, and it has been referred to as a paired or unpaired continuation of the recurrent nerve. The word oesophageal seems more appropriate than any of the other names because the nerve, whether paired or unpaired, runs for most of its course along the oesophagus, and many small branches innervate the oesophageal wall.

EXPLANATION OF FIGURES IN PLATE I

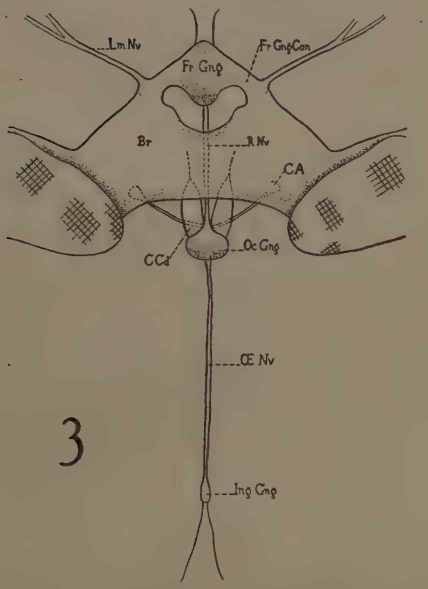
Fig. 3. Dorsal view of Stomodaeal Nervous System of *Libellula* sp. (adult); aorta and oesophagus removed.

Fig. 4. The Stomodaeal Nervous Stysem of *Magicicada septendecim* L.
- A. Lateral view; M, dilator muscle, attachment to pharynx not shown.
- B. Frontal view of corpora cardiaca and corpora allata, somewhat diagrammatic.
- C. Posterior view of corpora cardiaca and corpora allata; aorta and oesophagus not shown.

Fig. 5. The Stomodaeal Nervous System of *Nezara hilaris* Say.
- A. Dorsal view; aorta partly removed.
- B. Dorsal view, detail of postcerebral structures; aorta and oesophagus removed.
- C. Ventral view; oesophagus removed.

Fig. 6. Dorsal view of Stomodaeal Nervous System of *Arilus cristatus* L.

(See page 345 for explanation of abbreviations.)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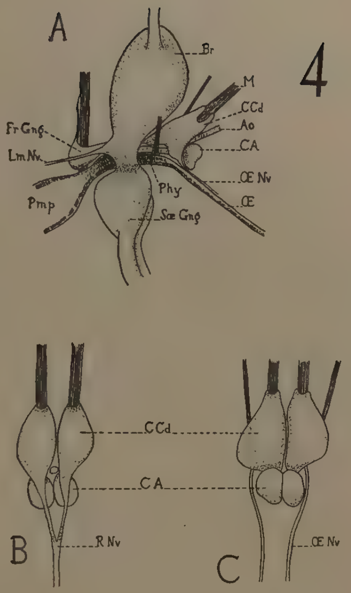
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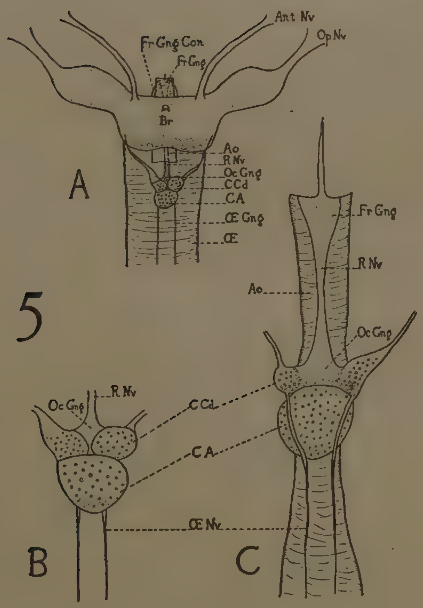
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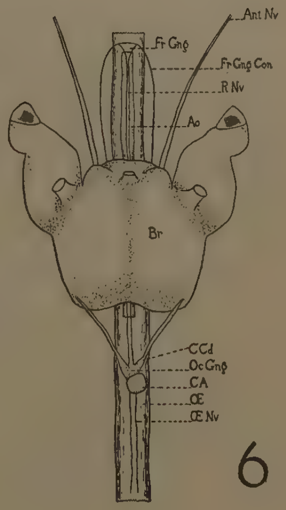
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The oesophageal nerves end in the ingluvial ganglia which have also been called the vagus, the splanchnic, the visceral, and the stomachic ganglia. In some insects there is a single ingluvial ganglion; in others it is absent. The ingluvial ganglia in *Schistocerca* are well developed. They lie along the posterior lateral walls of the crop which are innervated by several branches from them.

THE STOMODAEAL NERVOUS SYSTEM OF A DRAGON FLY

In a dragonfly naiad (fig. 2) the frontal ganglion connectives arise from tritocerebral lobes of the brain which extend anteriorly to the labrum. The recurrent nerve runs back under the brain on the dorsal wall of the pharynx to the occipital ganglion. From this ganglion the corpora cardiaca branch anteriorly and the corpora allata, posteriorly. These five structures are very closely associated with each other. A short nerve connects each corpus cardiacum with the protocerebrum. A single oesophageal nerve runs posteriorly to the ingluvial ganglion which lies on the dorsal wall of the oesophagus where the latter begins to enlarge and form the crop. The corpora cardiaca are slightly dorsad of the occipital ganglion, and the aorta runs between them and stops just behind the brain.

In the adult dragonfly (fig. 3) the frontal ganglion is close to the brain and the frontal ganglion connectives are short and thick. In contrast to their position in the naiad, the corpora cardiaca are slightly ventrad of the larger part of the occipital ganglion, and the anterior parts of them are situated under the brain with which they are connected by short, thin nerves. The corpora allata also are located under the brain. They are much farther from the occipital ganglion in the adult than in the naiad. The median oesophageal nerve connects the occipital ganglion with the ingluvial ganglion which is located on the dorsal wall of the anterior part of the crop. A pair of nerves extends posteriorly from the ingluvial ganglion.

Microtome sections[3] of the corpora cardiaca and occipital ganglia of several dragonfly adults gave no indication of the glandular nature of those structures. They appear to consist of nervous tissue, but sections of the corpora allata showed that these bodies were composed of vacuolated cells of a glandular type.

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[3] The insects were fixed in toto in Carnoy—Lebrun and Bouin's fluids, either of which gave good results. The parts to be sectioned were dissected out before embedding. Standard haematoxylin was a satisfactory stain.

Explanation of Figures in Plate II

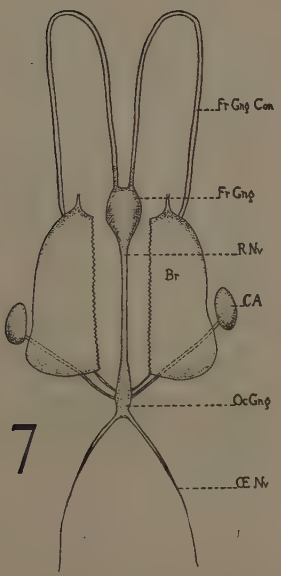
Fig. 7. Dorsal view of Stomodaeal Nervous System of the Larva of *Passalus cornutus* Fab.

Fig. 8. Dorsal View of Stomodaeal Nervous System of *Prodenia eridania* Cram. Adult.

Fig. 9. The Stomodaeal Nervous System of *Sceliphron cementarium* (Drury).
A. Dorsal view. B. Lateral view.

Fig. 10. The Stomodaeal Nervous System of *Erax* sp.
A. Lateral view. B. Frontal view.

(See page 345 for explanation of abbreviations.)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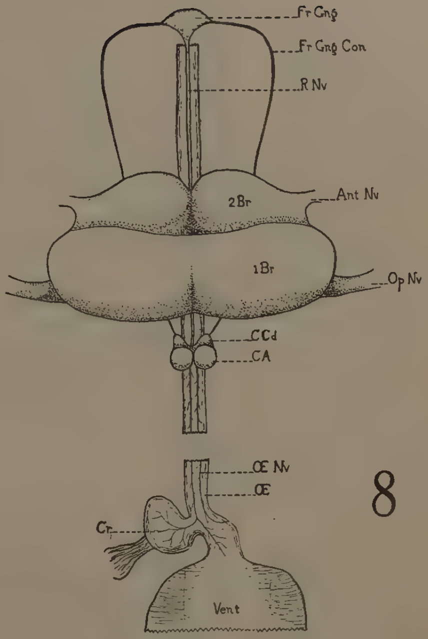
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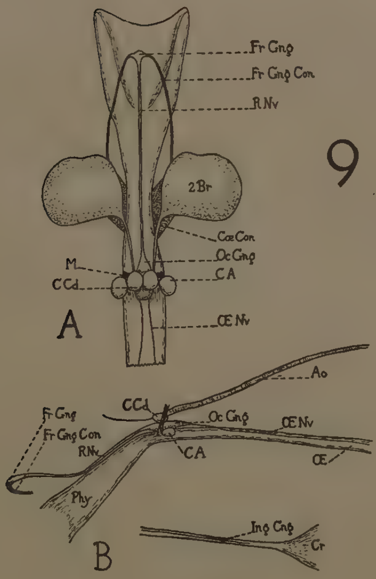
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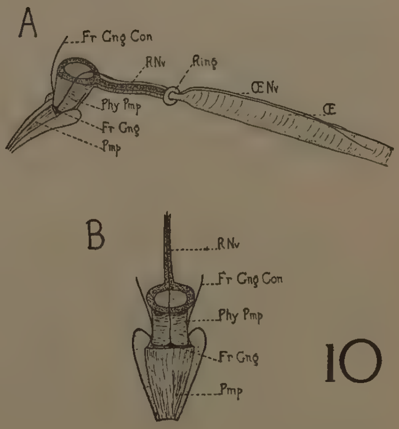
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THE STOMODAEAL NERVOUS SYSTEM OF A CICADA

In *Magicicada septendecim* L. (fig. 4) the frontal ganglion is located just above the stomodaeum near the junction of the latter with the sucking pump. The short recurrent nerve runs under the brain, then bifurcates. The branches run to the paired corpora cardiaca which are irregular in shape and practically surround two of the dilator muscles of the pharynx. (The attachment of this pair of muscles to the pharynx is omitted in fig. 4A). Paired oesophageal nerves pass posteriorly from the corpora cardiaca, but there are no ingluvial ganglia. The paired corpora allata are in contact with the posterior ventral parts of the corpora cardiaca. All of these bodies are dorsad of the stomodaeum. Nerves passing from the corpora cardiaca directly to the brain were not found.

With regard to the absence of a distinct occipital ganglion in the cicada, it is of interest to note that according to Bugnion (1908) such a structure is not present in the lantern-fly, *Fulgora*, and that Pflugfelder (1937B) found no occipital ganglion but distinct corpora cardiaca in the aphid, *Pemphigus*. However, according to the same author the scale insect, *Lecanium*, appears to have a distinct occipital (hypocerebral) ganglion but lacks corpora cardiaca.

THE STOMODAEAL NERVOUS SYSTEM OF A BUG

In the green stink bug, *Nezara*, (fig. 5) the frontal ganglion is a triangular structure, somewhat flattened. The recurrent nerve is short and rather large in porportion to the other nerves. The corpora cardiaca are fused ventrally but are distinctly lobed dorsally. They form a plexus with the occipital ganglion from which the paired oesophageal nerves originate. The latter pass under the unpaired corpus allatum which is contiguous with the posterior part of the plexus mentioned above.

In the wheel bug, *Arilus* (fig. 6) the recurrent nerve is longer than in *Nezara*. The postcerebral parts of the stomodaeal nervous system are similar to those of *Nezara*. There is a fusion of the corpora cardiaca with the occipital ganglion, and the corpus allatum rests on the posterior part of this mass. Numerous specimens of these two bugs were examined, and it was found that the asymmetry of the corpora cardiaca and corpus allatum is rather constant—a condition which has been observed in other orders of insects.

THE STOMODAEAL NERVOUS SYSTEM OF A BEETLE

The general pattern of stomodaeal innervation was found to be similar in the green June beetle, *Cotinis nitida* L., and in the larva of *Passalus cornutus* Fab. The frontal ganglion connectives in the larva of *Passalus* (fig. 7) run forward a considerable distance before turning back to the tritocerebrum. Corpora cardiaca were not observed; it is possible that they are fused with the occipital ganglion, for there is a pair of nerves joining it to the brain. The paired corpora allata are located at the side of the brain and the nerves which join them to the occipital ganglion run under the brain. From the occipital ganglion the paired oesophageal nerves branch posteriorly and follow the oesophageal wall. Ingluvial ganglia are absent.

THE STOMODAEAL NERVOUS SYSTEM OF A MOTH

The stomodaeal nervous system of lepidopterous larvae has been reported to be rather complex. In the larva of *Protoparce sexta* Johanssen the pattern of stomodaeal innervation appears to be similar to that of a noctuid caterpillar described by Snodgrass (1935). The paired corpora cardiaca (lateral anterior ganglia) are some distance from the recurrent nerve, and there is no distinct occipital ganglion. From each corpus cardiacum, in addition to the nerve joining the recurrent nerve, there are fibers passing to the brain, the mandibular nerve, the mandibular muscles, and the corpora allata. Nerves from each corpus allatum run to the corresponding salivary duct. It is probable that there is a sheath of nervous tissue surrounding the corpora cardiaca and allata. A small ingluvial ganglion is present.

The stomodaeal nervous system of the southern army worm moth, *Prodenia eridania* Cram. (fig. 8) is quite different from that of lepidopterous larvae. The corpora cardiaca are fused and the median parts of them are joined by the recurrent nerve to form what is probably the occipital ganglion. Two oesophageal nerves extend posteriorly from this mass, part of which is between the ventral parts of the corpora allata. The dorsal parts of the corpora allata are in contact with each other. About halfway down the oesophagus each of the oesophageal nerves sends off a lateral nerve to the salivary glands. Many short nerves branch from the oesophageal nerves to innervate the oesophagus; and the crop, which is a lateral diverticulum, is innervated by branches from them. They end in numerous fine fibers anterior to the ventriculus.

THE STOMODAEAL NERVOUS SYSTEM OF A WASP

In the wasp, *Sceliphron cementarium* (Drury) (fig. 9) the frontal ganglion is rather small and the recurrent nerve runs posteriorly from it to a distinct occipital ganglion. The corpora cardiaca are located above the latter and are connected with the deutocerebrum by rather thick nerve fibers. Below the occipital ganglion on each side of it are the corpora allata. Paired oesophageal nerves pass from the occipital ganglion to the two small ingluvial ganglia on the sides of the narrow posterior part of the oesophagus.

THE STOMODAEAL NERVOUS SYSTEM OF A ROBBER FLY

In connection with experimental work on the cause of pupation in various Diptera, Burtt (1937) studied the stomodaeal nervous system and found that in *Chironomus* and *Tipula* larvae there are well-defined occipital ganglia, corpora cardiaca (oesophageal ganglia) and corpora allata. An investigation of the larva of *Tipula abdominalis* Say has essentially corroborated the description given by Burtt.

Many of the early investigators described a ring of supposedly nervous tissue surrounding the aorta behind the brain in cyclorrhaphous Diptera. Recent experimental work by Hadorn (1937), Burtt (1937A, 1937B) and De Bach (1939) has indicated that this group of cells known as Weismann's ring secretes a hormone inducing pupation in *Drosophila*, *Calliphora*, and *Musca*. Fraenkel (1935) states that there exists in *Calliphora* larvae no organ which can be homologized with the corpora allata in other insects.

It is of interest to note that Weismann's ring has so far been reported to exist only in cyclorraphous Diptera. In the robber fly, *Erax*, a similar ring is present. In this insect (fig. 10) the frontal ganglion rests on the anterior wall of a pharyngeal or secondary sucking pump. Dorsally and posteriorly the pharynx has a circular sclerotic plate with a narrow extension to the beginning of the oesophagus. Large muscles are attached to the circular plate, and the recurrent nerve, following the dorsal wall of the pharynx, wends its way between the muscles. Along the extension of the plate the recurrent nerve swells to form what is possibly an occipital ganglion. At the union of the pharynx and oesophagus, the ring of tissue mentioned above surrounds the gut. The recurrent nerve unites with this ring. Posteriorly an oesophageal nerve leaves the ring and passes along the dorsal wall of the oesophagus. Near the end of the oesophagus the nerve bifurcates, but there are no ingluvial ganglia. The frontal ganglion connectives are apparently the only nerves extending from the brain to the stomodaeal system. Whether the ring described above corresponds to the corpora cardiaca or corpora allata is unknown. However it seems logical that it is the homologue of Weismann's Ring.

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KEY TO THE NEARCTIC GENERA OF WATER BEETLES OF THE TRIBE AGABINI, WITH SOME GENERIC SYNONYMY

(Coleoptera: Dytiscidae)[1]

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Upon using the key to the genera of the tribe Agabini as given in Bradley's "A Manual of the Genera of Beetles of America, North of Mexico," page 47, it becomes evident that there must have been some confusion in translating and rearranging Zimmerman's key (1919: 203–205). For example, the characters attributed in Bradley to *Agabinus* Crotch, are actually those of *Agabus* Leach (s. str.), while those for *Agabus* refer to the *Gaurodytes* Thomson of Zimmermann's paper. In addition, *Carrhydrus* Fall has been interpolated, although because of its unequal metatarsal claws it would have run to *Colymbetini* in the key to the subfamilies and tribes (page 45, couplet 10).

These facts suggest the need for another key to the genera of our *Agabini*, and the necessity of reconsidering the composition of this and allied tribes. Such a study is under way, but is not likely to be completed for some time; the following notes and key may be of use in the interim.

Tribe **Agabini** Sharp[3]

Sharp, 1882, Sci. Trans. Roy. Dublin Soc., (2) 2: 491.

Sharp separated the subfamily *Colymbetinae* into three tribes; the *Agabini* he distinguished by the linear group of ciliae at the posterior apical angle of the metafemora; the *Colymbetini* and a group of unassociated genera, lacking this group of ciliae, were separated by the fact that the genera of the former have sclerotised and transversely grooved

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[3] Actually Sharp proposed it as a "group," referring to names ending in *inae*, e. g., *Colymbetinae*, as tribes.

pleurites of the second abdominal segment. By this method, the genera *Hydrotrupes* Sharp, *Agabinus* Crotch, *Agabus* Leach, *Ilybiosoma* Crotch and *Ilybius* Erichson (and some others which do not occur in our fauna) were placed in the tribe *Agabini*, while *Scutopterus* Crotch, *Rantus* Stephens and *Colymbetes* Schellenberg went into *Colymbetini*.

Zimmermann (1919: 196) preferred the condition of the metatarsal claws as an ordinal character; the *Agabini*, with equal hind tarsal claws, thereby lost the genus *Ilybius*.

Unfortunately there are objections to both these systems. As Zimmermann pointed out, the metafemoral-cilia character practically fails in one section of the genus *Agabus* ("Subgenus" *Hydronebrius* Jakowlew, 1897). On the other hand his separation by the metatarsal claws also fails, for in the two species *Agabus erichsoni* Gemminger & Harold and *A. subtilis* Erichson, the claws are equal in the females, but appreciably unequal in the males.

It seems likely that the curious transverse rugae on the pleurites of the second abdominal segment may be of considerable phylogenetic importance. They lie between the dorsal ends of the second sternite and the corresponding spiracles, and are seen only by raising or removing the elytra; the pleurites of the following segments are never transversely rugose. Though the function of these rugae is enigmatic, they offer a clear-cut method of segregating the genera involved; they are either strongly defined—*Colymbetes*, *Rantus*, *Scutopterus*, and *Hoperius* Fall,—or completely absent—*Hydrotrupes*, *Agabinus*, *Agabus*, *Ilybius*, and *Carrhydrus* Fall. Elsewhere, they are known to occur only in *Dytiscus* Linnaeus and *Hyderodes* Hope, which two genera constitute the tribe Dytiscini; and very weakly in *Platambus* Thomson, a palaearctic genus included in the Agabini. Their occurrence in *Platambus* is puzzling, but since the species of this genus have certain other aberrant characters, careful study may suggest placement in another tribe.

Accordingly I am in favor of Sharp's system, especially when one considers that unequal metatarsal claws are found in a number of unassociated genera throughout the phylogeny of the Dytiscidae, for which reason they may be looked upon with suspicion as a tribal definition. There are two other points which argue strongly for placing *Ilybius* with *Agabus*, rather than with *Colymbetes*. F. Balfour-Browne (1934, 1935) has investigated the forms of the proventriculus in the Dytiscidae, and finds that on this basis, *Ilybius* is close to *Agabus* and allies; while Goodliffe (1939), studying the wing venation, shows clearly that *Ilybius* should be associated with *Agabus*. On habitus, both *Ilybius* and *Carrhydrus* are as strongly agabine as *Hoperius* is colymbetine.

KEY TO THE NEARCTIC GENERA OF AGABINI

Note.—The genera here included in the tribe Agabini will all run to couplet 10 (page 45) in Bradley, but will not remain together therein. They may be separated from the other tribes of Colymbetinae by the following combination of characters: metafemora with a linear group of ciliae near the posterior apical angles (figs. 11, 12); pleurites of second abdominal segment (elytra must be raised to see them) not strongly sclerotised, without transverse rugae; metatarsal claws equal or not.

1. Metacoxal processes in the form of rounded lobes (fig. 12) 2
   Metacoxal processes parallel-sided, lateral margins straight to the apices (fig. 11) .... **Agabinus**
2. Metatarsal claws of equal length (fig. 12); if slightly unequal, then both are very short, only one-third length of fifth tarsal segment 3
   Metatarsal claws obviously unequal, outer one of each pair two-thirds or less length of inner claw (fig. 10) 4
3. Labial palpi very short, terminal segments subquadrate (fig. 8) . . . **Hydrotrupes**
   Labial palpi approximately as long as maxillary palpi, terminal segments linear, not subquadrate (fig. 7) .... **Agabus**
4. Labial palpi with penultimate segments enlarged, triangular in cross-section, the faces concave and unequal (fig. 9); genital valves of female dorso-ventrally flattened, not armed with teeth .... **Carrhydrus**
   Labial palpi with penultimate segments linear, not enlarged and triangular (fig. 7); genital valves of female laterally compressed and saw-like, with series of sharp teeth along upper edge .... **Ilybius**

Genus **Agabus** Leach

Leach, 1817, Zool. Miscellany, 3: 68 and 72.

Type of the genus, *Dytiscus serricornis* Paykull, 1799; the only species cited by Leach.

This large Holarctic genus has had many of its species, or groups of them, removed as distinct genera or subgenera. The genus, *sensu lato*, is obviously composite and unwieldy, but a rather detailed study of the Nearctic and of many of the Palaearctic species has shown the inter-relationships to be complicated; until a thorough revision can be made by someone having access to all the known species of both faunas, only inaccuracies can result from segregating our species under the names already proposed. In addition, there is the fact that many of the recently described forms have proved to be connecting links between groups of species previously considered as well defined and clearly separated from all others. This appears to be a general tendency; it has shown very clearly in Kinsey's studies on the species and genera of Cynipidae (1936), and has been commented upon by Saylor (1940: 61), quoting Arrow.

Accordingly, though cognizant of the names proposed at the expense of *Agabus*, the genus is here used in its broadest sense.

Key. The only recent key to our species is that by Fall, 1922. (See list of References at end of this paper). Many new species have been described since Fall's article.

Genus **Ilybiosoma** Crotch

Crotch, 1873, Trans. American Ent. Soc., 4: 398 (in key), 413 (description).

Type of the genus, *Ilybius regularis* Leconte, 1852; designated by Crotch, 1873.

In his key, Crotch separated this genus from *Ilybius* by the equal metatarsal claws, from *Gaurodytes* of his paper by the lineal metasternal sidepieces, and from *Agabus* by the simple antennae of the males. In his discussion (p. 414) he made an obvious mistake, saying: "This genus differs from *Ilybius* by the sexual characters, and from *Agabus* by the narrow laciniae," when he meant *Agabus* and *Gaurodytes* respectively. Crotch included *Colymbetes bifarius* Kirby with a question mark, saying that it might represent a new genus, or belong in *Eriglenus* Thomson.

Regimbart (1878: 461) considered Crotch's genus to be a synonym of *Eriglenus* Thomson[4], but Sharp gave it standing in his monograph on the Dytiscidae (1882); it was not further disturbed until 1936, when Guignot, without further comment, placed it as a subgenus of *Agabus* in his key.

Recent studies have shown that it is quite impossible to separate *Ilybiosoma regularis* from a group of species in the genus *Agabus*, containing *lugens* Leconte, *seriatus* (Say), *brevicollis* Leconte, *ilybiiformis* (Zimmermann) and *minnesotensis* Wallis. The male genitalia of these species are remarkably similar[5]; and readily separable from those of our other *Agabus*. The narrow tongue-like metasternal wings[6] of *regularis*, considered to be diagnostic of the genus *Ilybiosoma*, are just as narrow in *minnesotensis*, slightly wider in *brevicollis* and *ilybiiformis*, wider still in *seriatus*, and broadest in *lugens* (figs. 1–6). Other important characters, such as the shapes of the prosternal processes and of the metalegs, the elytral sculpture, and the convexity of the body, show the same gradations from one extreme to the other in these species, suggesting that the series is a natural association.

Genus **Apator** Semenov

Semenov, 1899, Horae Soc. Ent. Russia, 32: 512.

Type of the genus, *Agabus kessleri* Hochhuth, 1871, (=*Colymbetes bifarius* Kirby, 1837, fide Zimmermann); designated by Semenov, 1899.

Semenov based the description of his genus *Apator* on *Agabus kessleri* Hochhuth, which he said is one of the most characteristic elements of the Central Russian water beetle fauna. He included Kirby's *Colymbetes bifarius*, though he had not then seen specimens of it; in relying on the description and figure given by Sharp (1882, p. 537 and fig. 170), he was misled as to the elytral sculpture, for Sharp's illustration is very poor; in fact it cannot compare with the one given by Kirby forty-five years earlier.

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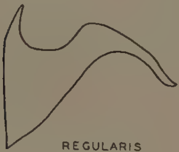
[4] Included in *Agabus s. lat.*, of the present paper.

[5] *A. cordatus* (Leconte) and *bjorkmanae* Hatch are allied to the above species, especially to *seriatus*, on the basis of the male genitalia, as are also the species of the *guttatus* group of the Palaearctic fauna.

[6] The shape of the metatarsal wing has been used by some workers as a primary character on which to separate subgenera and even genera, at the expense of *Agabus s. lat.* Study of our species and of many from the Palaearctic fauna, has convinced me that the shape of the metasternum has varied independently a number of times in the history of the genus.

Explanation of Plate I

Figs. 1 to 6. Right half of metasternum (ventral view) in each of six species of *Agabus*. (Drawn to the same scale.) Fig. 7. Labial palpus of *Agabus clavicornis* Sharp. Fig. 8. Labial palpus of *Hydrotrupes palpalis* Sharp. Fig. 9. Labial palpus of *Carrhydrus crassipes* Fall. (Figs. 7 to 9 are not drawn to the same scale.) Fig. 10. Apex of metatarsus of *Ilybius pleuriticus* Leconte, to show unequal claws. Setae omitted. Fig. 11. Ventral view of *Agabinus glabrellus* (Motschulsky) to show form of metacoxal lobes. Fig. 12. Same, of *Agabus punctulatus* Aubé. (Figs. 11 and 12 are drawn to the same scale. Tibial and tarsal setae are omitted.)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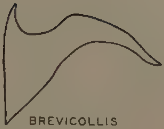
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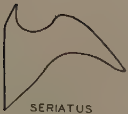
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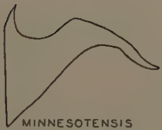
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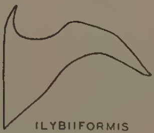
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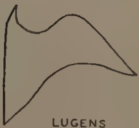
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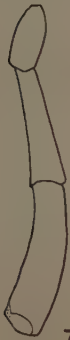
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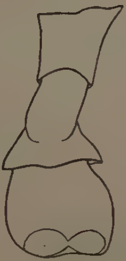
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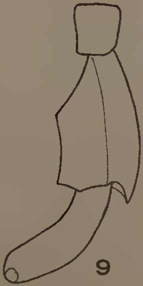
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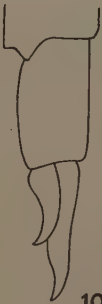
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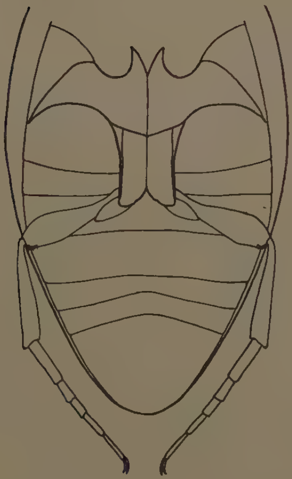
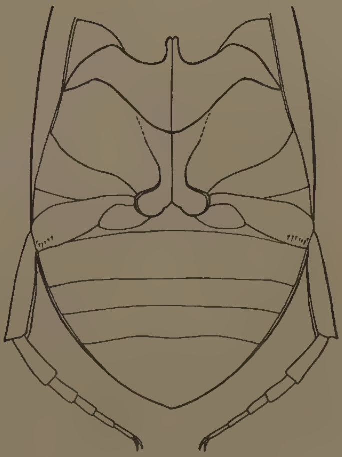

11 AGABINUS *sp.*


12 AGABUS *sp.*

Apator was given as a subgenus of *Gaurodytes*[7] by Zimmermann in 1919 (p. 204); as a distinct genus in his list of the Dytiscidae of the world (1920: 185); and again as a subgenus of *Gaurodytes* in 1934 (p. 149). In this last reference he gives *A. kessleri* (Hochhuth) as a synonym of *bifarius* (Kirby).

Semenov relied upon the following characters to separate *Apator* from *Agabus* and allied genera: (1) the aciculate elytral sculpture: in the basal two-thirds the elongate impressions are sub-oblique; in the posterior third, shorter and transverse; (2) the short, narrow, imperfectly-formed wings; (3) the tiny hairs, pointing straight downward, which arise from punctures along the face of the epipleurae, except in the basal third and near the elytral apices.

A careful examination of one hundred and fifty-six *bifarius*, all from Canada and the north-eastern United States, has shown that none of the above three characters will distinguish *Apator*. (1) The aciculate elytral sculpture may completely disappear; in a pair before me, from Marion, Massachusetts (Bowditch), the male is devoid of aciculate sculpture, while the female has a vague trace near the elytral apices. Such specimens are *Agabus*, clearly belonging to the association of species known as the genus or subgenus *Eriglenus* in European literature. (2) The wings are found to be dimorphic; irrespective of sex, almost exactly 45 per cent of the one hundred and fifty-six *bifarius* examined were found to have wings of normal size and shape; the remainder had short, narrow wings, and are apparently incapable of flight.[8] (3) The series of little eye-lash like hairs along the epipleurae are readily seen on clean specimens of *bifarius*; but they are equally apparent in the Palaearctic *Agabus labiatus* (Brahm), *undulatus* (Schrank), and *clavicornis* Sharp, in the Nearctic *hudsonicus* Leech, *versus* Brown, etc., and in *Carrhydrus crassipes* Fall.

For these reasons, *Apator* is here considered to be a synonym of *Eriglenus* Thomson.

Genus **Ilybius** Erichson

Erichson, 1832, Genera Dyticeorum, p. 18 (in synopsis of genera), and 34 (description).

Type of the genus, *Dytiscus fenestratus* Fabricius, 1781; designated by Westwood, 1838.

A genus of Holarctic distribution, but containing only about one-quarter as many species as *Agabus s. lat.*

The species of *Ilybius* are most readily separated from those of *Agabus* by their unequal metatarsal claws; however, as has already been mentioned, this is a sexual character in *A. erichsoni* and *A. subtilis*. An excellent difference between the two genera is found in the external female genitalia: in *Ilybius* the genital valves are laterally compressed and saw-like, with a series of sharp teeth along the upper edges; in *Agabus* the valves are never so armed. A pubescent area on the under side of each elytron, near the apex, was listed by Leconte and Horn

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[7] Included in *Agabus s. lat.* of the present paper.

[8] This subject is discussed and illustrated in the following paper.

(1883: 65) as typical of *Ilybius*, but it occurs also in *Carrhydrus* and in various species of *Agabus*.

Key. Excellent keys to both males and females of the Nearctic species have been published by Wallis, 1939.

Genus **Carrhydrus** Fall

Fall, 1922, Rev. N. Am. spp. *Agabus*, with . . . new genus . . . tribe Agabini, p. 35.

Type of the genus, *Carrhydrus crassipes* Fall, 1922, the only species known.

C. crassipes is one of the most interesting species of Dytiscidae in our fauna. In describing it from a single male specimen (collected at Edmonton, Alberta, by the late F. S. Carr), Fall considered that it should be placed next to *Ilybius*, and both included in the Agabini; with this I certainly agree. The unequal metatarsal claws appear to ally it with *Ilybius*, but the triangular and greatly enlarged penultimate segments of the labial palpi are at once diagnostic. In other attributes, especially the elytral sculpture, the male and female genitalia, and the male secondary sexual character, *Carrhydrus* is closely allied to the genus *Agabus s. str.*, i. e. to *A. serricornis* (Paykull), *clavicornis* Sharp, and *verus* Brown.

Genus **Agabinus** Crotch

Crotch, 1873, Trans. Am. Ent. Soc., **4**: 385 (in key), 397 (description).

In describing this genus, Crotch also erected for it the tribe Agabinini, no longer recognized.

Type of the genus, *Colymbetes glabrellus* Motschulsky, 1859; designated by Crotch, 1873.

Two small black species from the Pacific Coast are assigned to *Agabinus*.

Key. See Leech, 1941: Canadian Ent. 73 (3): 53.

Genus **Hydrotrupes** Sharp

Sharp, 1882, Sci. Trans. Roy. Dublin Soc., (2) **2**: 491 (in key), 492 (description of type sp.).

Type of the genus, *Hydrotrupes palpalis* Sharp, 1882, the only species yet known.

Small black water beetles, found in streams in the Sierras of California. Length, 4 to 5 mm.

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THE NUMBERS OF ANTS IN ANT COLONIES

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The number of ants in an ant hill is a question of perennial interest. Forel's estimate of a maximum of half a million to a hill was not supported by Yung's actual enumerations (1900) which showed that of five hills of *Formica rufa* only one approximated one hundred thousand ants, the other four being well below that number. These lower figures were substantiated by the subsequent maximum enumerations of 2500 for a colony of *Camponotus pennsylvanicus* by Pricer (1908), of 8239 for one of *Formica exsectoides* by Andrews (1929), and of 12,358 for a nest of *Pogonomyrmex barbatus* by Wildermuth and Davis (1931). These and other like results led Bodenheimer (1937) to conclude that the populations of ant colonies vary, depending upon species and stages of development, from a few dozens to about a hundred thousand. This general statement has been supported by the counts of Pickles (1935, 1936) whose work was apparently unknown to Bodenheimer. Cory and Haviland (1938), however, subsequently described a nest of *Formica exsectoides* which they estimated to contain 238,510 ants (probably subject to a slight reduction according to Forbes (1938). This number more than doubles Bodenheimer's maximum limit but even it falls well below Forel's half million. In most of these contributions comment is made on the paucity of information of any kind in the literature on the size of populations in ant colonies. The following account contains an estimate of the number of immature individuals in an active nest of the dusky ant, *Formica fusca* Linn., that had been raided by the slave-making species *Formica sanguinea* Latr. I am indebted to Dr. Falconer Smith for the identification of these species and to Professor C. T. Brues for references to the literature.

The nest of the dusky ants under consideration was in a grassy open lawn and covered an area of about half a square meter. It had numerous apertures. The nest of the attacking red ants was also in open grassy land and distant some twenty meters from the nest of the invaded species. Between these two nests was a more or less direct trail a few centimeters wide over which the red ants were traveling rapidly in both directions. These ants when first noticed were in many instances seen to be carrying in their mandibles single dusky ants all of which were in process of transportation from the nest of the dusky colony to that of the red one, for they were never seen being carried in the opposite direction. The dusky ants were evidently captured individuals that were being taken to their new habitation. Late in the afternoon of the first day on which this show attracted attention pale-covered individuals appeared among the transported population. On close examination these were seen to be larvae, pupae, or occasional callows. Like the transported adults these pale individuals were always being carried in the direction of the red ant nest. On close inspection they were found to be immature individuals of the dusky ant. At one place in the lawn the trail passed over a section of black garden hose which was so sunk in the sod that the ants were unable to pass under it and were of necessity obliged to climb over it. As the scattered procession marched over this hose it was very easy to count the ants that were carrying pale individuals because of the contrast in color of these individuals with the black hose. On the basis of these counts it was easy to determine the rate at which the immature dusky ants were being transported by the red ones.

The transportation of the pale individuals began in the late afternoon of the first day, about five o'clock, and lasted until eight o'clock that evening when with the oncoming of coolness the procession ceased. The trail was inspected during the night and no ants were seen at any time upon it. Presumably their operations stopped during the night. On the next day transportation of pale individuals began at about ten o'clock in the morning and lasted until near eight in the evening. During the second night there was again no sign of activity on the trail. On the third day transportation of pale ants occurred beginning in the morning and covering a period of about five hours. After that, though the red ants were still active, few or no pale individuals were seen to be transported. The total period of transportation for the three days thus amounted to about 18 hours. Over this period the rate of transportation was fairly uniform.

As the pale individuals were carried over the black hose they were counted for intervals of five minutes each. Twenty-one of these counts were made. They varied from 54 to 65 and averaged 59.4. Assuming this average to be reasonably correct as a sample of the eighteen hours it follows that the total number of immature ants transported by the red ants in that period must have been a little over 12,800. As the nest of the dusky ants was a disfigurement to the lawn where it was located it was dug up after the invasion of the red ants had ceased. The soil of this nest was carefully examined and only 56 immature ants were found in it. This showed that most of the immature dusky ants had been removed by the raiders and left the general estimate of 12,800+ as essentially correct. The season of this exploit was the early part of August, 1941, and the nests of both species of ants seemed to be in full activity. It is fair to conclude then that a vigorous nest of *Formica fusca* may contain in midsummer some twelve to thirteen thousand immature individuals.

Although relatively few workers have recorded the total populations of ant colonies still fewer have had the opportunity of noting the numbers of classes in these populations. In fact the only detailed counts of this kind are those of Pickles (1936) who recorded the subpopulation numbers in the three species of ants whose nests were subjected to enumeration by him. In *Acanthomyops flavus* a nest of a total of 5613 individuals contained 959 immature ants. In one of *Myrmica ruginodis* with a total of 1534 individuals there were 249 pupae. And in a small nest of *Formica fusca*, the same species upon which the present report is based, of a total of 275 ants over a third or 102 were immature. These numbers are too scanty to allow of any reasonable comparisons. Nor does the number arrived at in this report have much general significance. It is but one additional enumeration which when added to other future counts may give a more detailed knowledge of the composition of ant colonies.

SUMMARY

An active, vigorous colony of the dusky ant, *Formica fusca* Linn., was closely estimated in August, on the basis of an invasion by the red ant, *Formica sanguinea* Latr., to contain from twelve to thirteen thousand immature individuals (larvae, pupae, and callows).

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NOTES ON THE BIONOMICS OF LIXUS FIMBRIOLATUS BOH.

(Coleoptera, Curculionidae)

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University of Illinois,[2]
Urbana

In 1889 Webster reported upon some of the habits of this snout beetle referring to it as *Lixus macer* Lec. The present paper, based on investigations carried out in the fall of 1939 and the spring and summer of 1940 at Urbana, Illinois, further contributes to the bionomics of this insect. The beetle was abundant along railroads, where the host plants grew profusely.

Emergence. The adults emerge from the pupal skins during the first three weeks of June. They remain several days or even weeks within the stems in which the larvae overwinter. Twenty adult beetles observed daily in the field remained within the stalks for an average period of six days before they attempted to escape. The exits were made through holes, 8 x 5 mm. in dimensions, gnawed in the side of the stems. Some of the beetles required several days to excavate the exit hole, others but a few hours. Some adults fail to make exit holes and die within the stems. Usually the beetles remain a day or two longer within the stems after constructing the exit holes. The majority emerge from the stalks during a three-week period beginning about the second week in June.

Feeding. Soon after emerging from their pupal chambers the adults begin to feed upon the edges of the leaves (Fig. 2, fi) of various composites. Webster (1889) observed both sexes feeding upon the foliage of *Helianthus.* In this locality, the sunflower, *Helianthus grosseserratus* Martens is eaten more than any other plant. Other plants upon which I found them feeding were Jerusalem artichoke, *H. tuberosus* L., common sunflower, *H. annuus* L., the sunflower, *H. scaberrimus* Ell., one of the rosinweeds, *Silphium integrifolium* Michx. and two species of goldenrod, *Solidago canadensis* L., and *S. altissima* L. The leaves of the cup plant, *Silphium perfoliatum* L., and prairie dock, *S. terebenthinaceum* Jacq. showed slight indications of having been eaten.

Oviposition. A period of several days, perhaps even a week or two, elapses between the time the adults emerge from the stems and the time egg-laying begins. During the egg-laying period pairs may be seen mating and *in situ.* The male rides around on the back of the female for periods exceeding an hour or more, mating with her during this interval. The female often continues eating on the edge of a leaf while copulating.

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[1] This report represents a portion of the thesis which was submitted in partial fulfillment for the requirements of the degree of Master of Science in the Graduate School of the University of Illinois, 1941. The work was done under the direction of Dr. W. V. Balduf, Associate Professor of Entomology at the University of Illinois.

[2] Contribution No. 216 from the Entomological Laboratories of the University of Illinois.

In 1872, Riley (1888) found that eggs had been deposited in maple-leaved goosefoot, *Chenopodium hybridum* L. and *Helianthus*. Coquillett (1883) observed females engaged in ovipositing in *Helianthus*. Webster (1889) also observed these beetles ovipositing in *Helianthus* and in *Silphium*. He considered it quite probable that they might oviposit in other similar plants. In this he was correct for I observed adult females oviposit in *Helianthus grosseserratus*, *Silphium integrifolium*, *Helianthus tuberosus*, *H. scaberrimus*, the cone flower, *Rudbeckia triloba* L., *Silphium terebinthinaceum*, *Solidago canadensis*, *S. altissima*, the petioles of the large basal leaves of *Silphium terebinthinaceum*, and the giant ragweed *Ambrosia trifida* L. The above plants are listed in order of preference. Other plants in which eggs were deposited are *Helianthus annuus*, *Silphium perfoliatum* and the common elder, *Sambucus canadensis* L. Many nest channels were found in the stems of waxy meadow rue, *Thalictrum revolutum* DC., which are hollow. I did not learn whether the insect actually oviposited or only prepared receptacles in the latter stem.

In the normal process of egg deposition, a female first places herself head downward upon the stem. Next she gouges out with her mandibles a narrow channel, by forward and backward movements of the rostrum. This channel is about a quarter of an inch in length, limited to the distance the female can reach without changing her position. It is not clean cut, but filled with matted fiber (fig. 1, mf). Remaining in the same position, she begins to excavate a burrow or egg-chamber slightly larger than the diameter of her rostrum directly into the pith. She brings her head out frequently to empty her pre-oral cavity of pith and frass. As she penetrates deeper into the stem she pushes her body away from the surface with her hind legs until she is almost in a horizontal position. Her recurved rostrum requires her to dig obliquely upward, rather than diametrically through the stem. As she progresses, her entire head is thrust within the stem to a point behind the eyes. When she has penetrated as far as she can reach she withdraws her head and makes a half-circle turn usually to the right so that her head is now directed upward. After inserting her abdomen into the egg-chamber she deposits an egg in the burrow. This is fastened with some adhesive substance to the wall of the chamber. The length of time required for this process is about fifty seconds. Following the deposition of this egg, the female executes a 180° turn to the right. Employing her rostrum she surrounds the egg with macerated pith and pushes it into place before deposition of the second egg which is likewise surrounded by pith in this manner (fig. 1, mp). After depositing the second egg, she fills the burrow with macerated pith by means of her mouth parts which are then used to pull the long matted fibers of the channel over the opening of the egg chamber. If more eggs are to be deposited the female backs up the stem slightly and gouges out another channel in which she constructs an egg chamber as before. The channel of this section of the nest connects with the first so that the two look as one (fig. 1). Although never observed, a second female might construct her nest adjoining that of another individual. The number of chambers composing the nests varied from one to ten.

Several variations from the normal egg-laying procedure were observed. One female was seen to construct the channel and egg-chambers while pointing upward upon the stalk causing the egg-chambers to point down the axis of the stem. Several nests of this nature were found. In a few instances females which did not have males *in situ*, as many did while ovipositing, swung their abdomens back and forth transversely, pendulum fashion, over the entrance of the chamber just before inserting an egg. In two such cases the swinging of the body continued for fifteen seconds.

Perhaps the paramount factor which determines the number of egg-chambers a female will construct for a given nest is a condition within the insect itself, namely the number of mature eggs present within its ovaries when excavating the nest. The primary external factor appears to be the toughness of the plant fibers in which the nest is being constructed. During the first half of July, when the plants are relatively young and tender, the majority of the nests are constructed in the basal portion of the stems. At this time there is a higher percentage of many-chambered nests in these regions than will be found a month later when the fibers in the basal portions tend to become tough and woody. During the last weeks of August the many-chambered nests are to be found in the upper extremities of the plants where the fibers are less woody, also the percentage of one- and two-chambered nests will have increased in the basal portion. These conditions suggests that the females become fatigued more easily when constructing nests in tough stalks and do not excavate many-chambered nests in them.

The location of the nests in the stems of *Rudbeckia triloba* and *Silphium integrifolium* would seem to indicate that the surface covering of the stem and the kind and arrangement of the leaves play an indirect part in determining the size of the nests. The former plant stem is quite hairy which apparently prevents the insect from climbing to any great distance up the stalk. In the case of the latter plant the leaves are opposite, sessile and chordate. Barriers are thus formed by the leaves which tend to prohibit the insect from advancing to the upper extremities where the fibers are less tough. The majority of the nests constructed in these two plants, therefore, are composed of but one or two chambers since they are limited to the basal regions where the fibers are more woody.

The most common number of egg-chambers to a nest is one, two being next most frequent (fig. 1), three next, and so forth to ten. Of 150 chambers examined 99 or 66 per cent contained two eggs per chamber, 36 or 24 per cent one egg per chamber while 15 or 10 per cent lacked eggs entirely.

Duration of Egg Laying and Egg Stage. The egg stage (fig. 3) was found to have a duration of from six to seven days. Eggs were discovered from June 26 to September 21, which indicate that the egg laying period extends from the latter part of June until the middle of September. Each female probably oviposits many times during that period. It is also probable that those excavating nests with one or two egg-chambers construct a larger number of nests than do those excavating many-chambered nests.

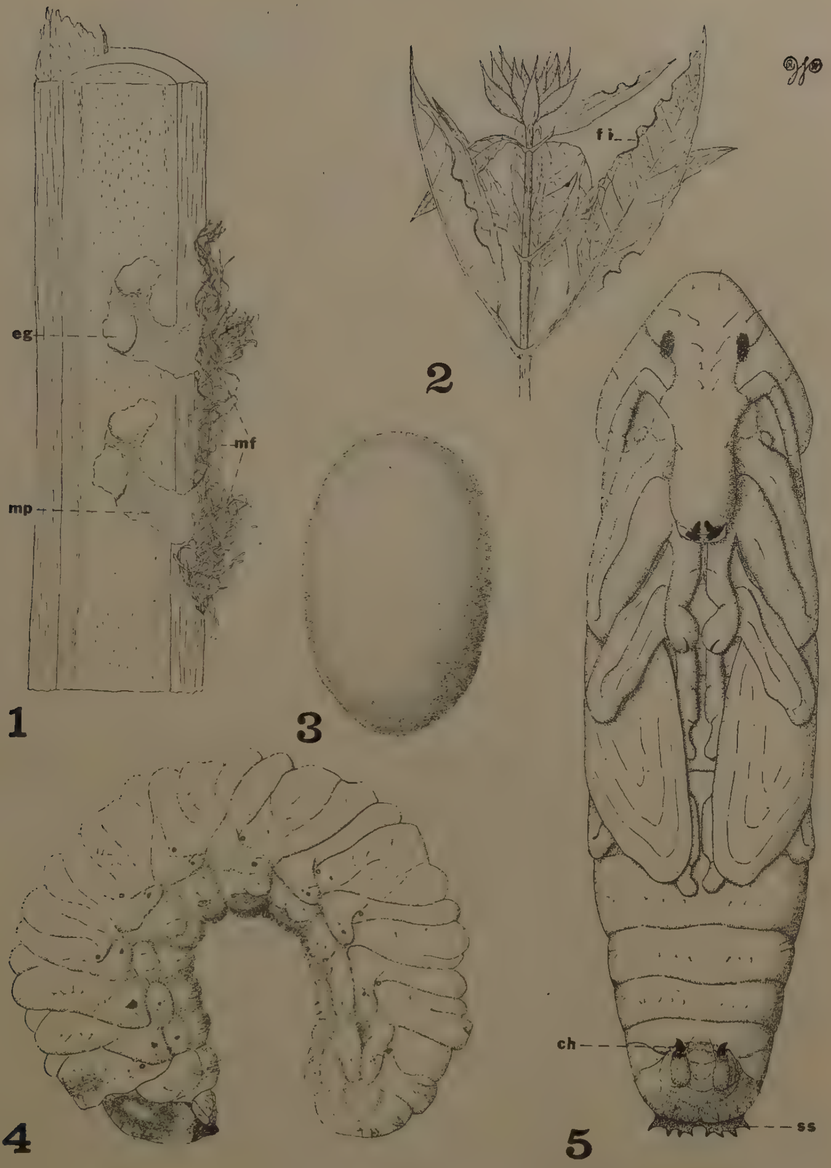

FIG. 1. Longitudinal section of a *Helianthus* stem showing position of eggs of *Lixus fimbriolatus:* eg—egg; mp—macerated pith; mf—matted fibers. 2. Injury to *Helianthus* leaves by feeding of adult weevils. fi—feeding injury. 3. Egg of *Lixus fimbriolatus*. 4. Larva of *Lixus fimbriolatus*. 5. Pupa of *Lixus fimbriolatus:* ch—caudal hooks; ss—spines.

Hostile Factors. Instead of hatching, some eggs turn black, decrease in size, and gradually disintegrate. Some of those deposited later in the season are destroyed by larvae of their own species. While eating their way up the stem these larvae crush or puncture the later-laid eggs with their sharp mandibles as they pass. Other coleopterous larvae may possibly destroy the eggs incidentally as do the *Lixus* larvae themselves. Several nests were found to contain larvae and pupae of a species of *Eurytoma*. This is a genus of the chalcidoid family Eurytomidae, order Hymenoptera. Although many adults of this hymenopteron were seen throughout the summer running about wildly over *Lixus* nests and annoying ovipositing females of this beetle, never were any seen to oviposit. Where its larvae or pupae were found within a nest no *Lixus* eggs were present. In a few cases, punctured *Lixus* eggs were found beside the eurytomid larvae. However, there were indications that the larvae eat the pith of the stem, hence the *Lixus* eggs may be destroyed by the wasp quite by chance. Further observations on the relation of *Eurytoma* to *Lixus* are needed.

Season of Larvae. The larvae of *Lixus* grow and develop during the summer months and pass the winter in the fully developed larval condition within the stems of the various host plants. Larvae may be found about eleven months of the year. It is probable that any given individual spends nearly ten months in the larval stage.

Larval Habits and Development. Upon hatching the larvae begin feeding on the pith of the stems in which the eggs were deposited, boring upwards towards the top of the plants. As they ascend they leave a passage packed with frass, and may proceed up the stalks to distances varying from two inches to three feet. Eventually, however, they turn around and eat downward for a distance of two to ten inches. Subsequently they again turn around and eat upward the same distance. Such upward and downward movements in the stem continue throughout the summer. By the second week in September, when the larvae become fully developed (fig. 4), each has excavated a chamber in which to pass the winter. These chambers vary in length among the different individuals, depending upon the distance the larvae had bored. In one instance the entire development of a larva took place in a section of stem two inches long, i. e., the larva was always within two inches of the nest where it hatched from the egg.

Webster (1889) expressed the belief that the larvae are not cannibalistic. However, I found evidence that they might be, especially in the early part of their development when they are eating their way up the stems. This evidence was provided by checking the number of larvae found within 50 stalks with the number of individuals one would expect to find, assuming all eggs hatched and all larvae lived. Investigations showed there were 68 per cent less larvae than one would expect to find. In my opinion not more than 20 per cent of the eggs were destroyed in the manners previously mentioned. I concluded, therefore, that some of the remaining 48 per cent must have been destroyed by other members of their own species, because of a cannibalistic tendency which may have developed from too crowded conditions.

After the larvae have reached maturity some of them girdle the stems from within during the last week in September and the first weeks of October. The process of girdling is performed with the mandibles, which scrape at the wall of the chamber while the insect is headed downward. Scraping begins at one point on a circle and continues around until the entire circumference has been girdled. The frass from this process is not eaten but fills the chambers about the larvae. Upon completing the girdle the larva tucks its head ventrally under the rest of the body and by many peristaltic contortions finally reverses its position so that its head points upward. It then pushes its way through the loose frass, which fills the lower portion of the chamber, by scooping and pushing it back under itself with head and thorax. After passing through the frass, a larva packs this material down so that a compact plug is formed. The wind easily breaks off the stalks at the point of girdling. The girdled sections may be found lying about on the ground or loosely attached to the main stalks during the late fall and winter. Stems were observed in which two girdles, about one-half inch apart, had been made by the same larva. Just why some larvae should girdle the stems completely while others do not even begin to do so is not known.

Larval Instars. I collected larvae in different stages of development during the summer in an effort to determine the number of larval instars. The length of the larvae and the width of the head capsules were measured. It was soon found that Dyar's law would not apply to this insect, for small larvae which appeared to be of an early instar often had larger head capsules than much larger larvae which were apparently of a later instar. Neither does Przibram's rule appear to apply to this species, for according to it the larvae undergoes fourteen molts. While this number is by no means impossible, it seems improbable in view of the fact that other beetles whose instars are known do not molt as many times.

Arrested Development. An effort was made to determine whether the arrested development of the larva during the winter is a true diapause, occurring irrespective of environment, or is only a direct response to environmental conditions. From a series of experiments it was found that individuals whose growth had become arrested during subfreezing weather continued their development when exposed to warmer temperatures. Although the effective temperatures were not determined it was noted that development took place about twice as fast at 80° F. as at 70° F. and much faster at 70° F. than at 60° F. At a constant temperature of 80° F. a humidity of 29 per cent was sufficiently low to kill 15 per cent of the larvae, while all individuals subjected to the same temperatures but to a humidity of 80 per cent lived. However, larvae exposed to the low humidity developed as rapidly as those exposed to the high humidity with the exception of the few that died. Even the latter individuals developed as rapidly as the others prior to their death. *Lixus fimbriolatus*, therefore, is homodynamic, i. e., development continues as long as temperature and humidity are favorable.

Before pupation in the spring, approximately 50 per cent of the larvae gnaw a small longitudinal slit, about 5 x 0.5 mm. in dimensions in the wall of their chambers. The presence of the slits make it very easy to find stems which contain pupae or larvae about to pupate.

I observed, from reared insects, that there is a very distinct change in the movements of the larvae prior to pupation. Instead of the slow, even, undulant motion, the larvae take on the quick, jerky, whip-like motion of the pupae a day or two before the last larval skin is molted.

The larvae transform to pupae in the spring. I found the first pupa on May 4. Judging from its dark color it had been in this stage for several days. The last pupa was found on June 16. Adults emerge after a duration of 21 to 24 days in the pupal stage.

In most insects the pupal stage is considered an inactive one. However, the pupa of *Lixus fimbriolatus* is very active. It is able to move rapidly up and down the interior of the stem with the aid of two caudal hooks and several rows of sharp abdominal spines. (fig. 5, ch, ss).

Enemies of the Pupa. Not infrequently the pupae fall prey to ants which enter their chambers through the small slits in the side of the stalks made by the larvae before pupating, or through open ends of the stems.

SUMMARY

1. There is one generation a year.
2. The adult, upon emerging from the pupal skin, remains within the stem several days before making an exit hole, and usually a few more days before actually departing from its cell.
3. In this area of their distribution, the adults begin to emerge from the stems of the various composites and other plants, in which the larvae overwinter, during the first or second week in June.
4. The adults feed and mate until mid-September upon many of the plants in which they oviposit.
5. Egg laying takes place from the last week in June until about the third week in September.
6. Nests are composed of egg chambers ranging from one to ten in number.
7. The eggs, of which there are usually two per chamber, hatch in six or seven days and the larvae begin to feed upon the pith of the stems becoming full grown after the middle of September.
8. During the first and second week in October many of the larvae girdle the stems from within.
9. *Lixus fimbriolatus* is a homodynamic insect.
10. Pupation first occurs within the stems about the first of May and lasts until about the middle of June.
11. From 21 to 24 days of the life of the insect are spent in the pupal stage.

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A REMARKABLE NEW HELIODINID (MICROLEPIDOPTERA)

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The discovery of a second species of the previously monotypic South American genus *Cyphacma* Meyrick, with characters which show that genus to be closely allied to *Cycloplasis* Clemens, suggests a discussion of the described species of these two genera, which form an interesting phylogenetic series, separated from the rest of the Heliodinidae by the greatly reduced venation and the obtect pupa.

Cyphacma Meyrick

Cyphacma Meyrick, Trans. Ent. Soc. Lond., 1915, p. 213.

The genus, erected for the single species, *chalcozela*, from Colombia, Ecuador and Peru, was characterized as follows:

> "Head smooth; ocelli present; tongue short. Antennae ¾, in male simple, basal joint elongate, without pecten. Labial palpi long, slender, filiform, curved, ascending, terminal joint somewhat shorter than second, pointed. Maxillary palpi obsolete. Posterior tibiae with rough projecting bristly hairs above, tarsi with very short bristles at apex of joints. Forewings with apex strongly bent down as though deformed; 1b simple, 2 from angle, 3–5 absent, 6 and 8 stalked, 7 absent, 9 out of 8 near base, cell open between 9 and 10, 11 from middle. Hindwings ⅓, linear-lanceolate, cilia 6; 3–5 absent, cell open between 2 and 6, 6 and 7 connate."

In a letter two years later Mr. Meyrick wrote: "Above is a sketch of the forewing of *Cyphacma* [herewith reproduced as fig. 2]; I think 5 is present as marked, not absent as stated, but these apical veins are very slight and faint."

Following the specific description of *C. chalcozela* is this statement: "This is a very singular little insect; the deflexed apex of forewing (giving a bluntly rounded convex aspect very different to its real shape as seen when denuded and flattened out) and metallic brilliance suggest that in life there must be considerable resemblance to a small Phytophagous Coleopteron."

The species described below as *Cyphacma tragiae*, new species, agrees closely with the genotype in venation, but differs from Meyrick's generic description in several other points, these points being just those in which *Cyphacma tragiae* approaches or agrees with *Cycloplasis*.

Specifically, *Cyphacma tragiae* differs from *C. chalcozela* in the black basal half of fore wing with silvery transverse mark.

Cyphacma tragiae, n. sp.

Head and thorax lustrous silvery metallic; the head behind with a raised frill of black scales (as in *Cycloplasis*); palpi grayish, rather short, but little curved, divergent, the third segment a little longer than the second and terminated by four expansible spines, which when appressed form the acute apex. Antennae about 2/3, the first segment but slightly more elongate than the corresponding segment in *Cycloplasis*. Fore wings arched, with surface convex and apex deflexed, black in basal half, shading to a grayish blue metallic color in outer half, with very elongate bluish metallic scales overlapping the black cilia. Just within the costal edge, at one-third the wing length, a silvery metallic, slightly inwardly oblique bar extends to the fold, or occasionally just beyond it, or may be reduced to a nearly circular spot next to costa. Hind wings and cilia nearly black. Legs black, with base and a broad band nearly to apex of posterior tibiae silvery, some of spines silvery. Abdomen silvery at base above, black toward tip; silvery beneath. Expanse: 4.8 to 5.6 mm.

Type—♂, near Cedar Creek, Jefferson County, Kentucky, reared (B. 1832) from a miner of leaves of *Tragia macrocarpa* Willd. (*T. cordata* Michx.) (Euphorbiaceae), imago May 6, 1941.

Paratypes—1 ♂, emerged August 5, 1940; 2 ♂'s, emerged May 6 and June 1, respectively, 1941; 1 ♀, August 5, 1940; 2 ♀'s, May 6 and May 8, respectively, 1941, all from Cedar Creek, Jefferson County, Kentucky; 1 ♂, emerged September 12, 1941, Mammoth Cave, Kentucky, all reared on *Tragia* under record number B. 1832.

For the present, all type material is in the collection of the author.

The completed mine (Fig. 5) is linear throughout and irregularly branched, with the aspect of a Dipterous mine. At its beginning the mine is a minute, somewhat circular blotch, with the frass in a patch in the middle. Remnants of the egg may be seen more or less distinctly at the margin or on the blotch, usually on the upper side of the leaf. The egg is flat and appears to be pressed into the leaf tissue. From the blotch, the first linear gallery starts out, and where not obliterated by the later irregular branching of the mine, may be recognized as much narrower than the rest of the mine. In making a new branch, the larva turns back a short distance before turning out from the older mine; this branch may in turn be branched, but more often the larva

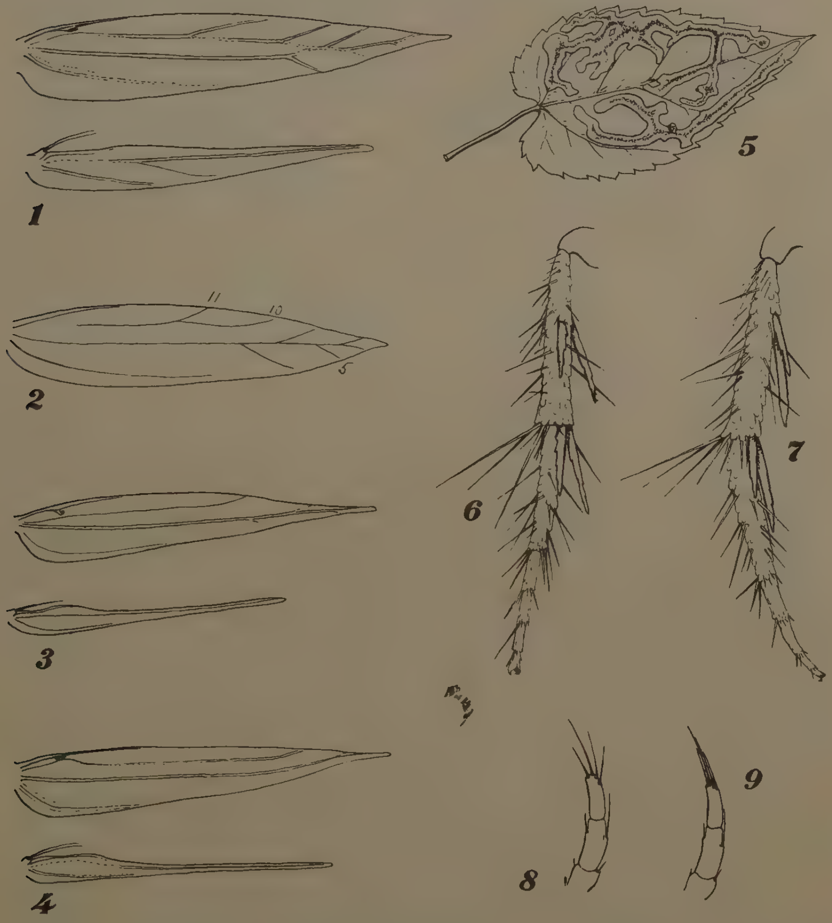

FIG. 1. Venation of *Cyphacma tragiae* n. sp. 2. Venation of fore wing of *Cyphacma chalcozela* Meyrick (after Meyrick). 3. Venation of *Cycloplasis habrarcha* Meyrick (drawing constructed from description). 4. Venation of *Cycloplasis panicifoliella* Clemens. 5. Leaf with three mines: one below; two above crossing one another as shown by the two eggs and first blotches (about natural size). 6. Posterior tibia and tarsus of *Cycloplasis panicifoliella*. 7. Posterior tibia and tarsus of *Cyphacma tragiae* n. sp. 8. Labial palpus of *Cycloplasis panicifoliella* with apical spines spread. 9. The same with apical spines appressed together.

returns again to the older mine. The frass is deposited along the middle of the mine. The parenchyma in the mine is to a great extent consumed. A leaf may contain several mines, crossing one another and running together.

The larva is pale, greenish while feeding, whitish after leaving the mine; head pale luteous, scarcely darker than the body, mandibles dark brown; prothoracic shield pale luteous, trapezoidal, but with sides slightly concave, anterior margin convex, and anterior angles acutely produced laterally; a similar chitinous plate on the ventral surface of the first thoracic segment, very pale and nearly concolorous with the rest of the body. Setae present. The three pairs of thoracic legs are present, the first pair very small; prolegs present on abdominal segments 3, 4, 5, 6 and 10, functional, but not well developed. Compare this with the much more specialized larva of *Cycloplasis panicifoliella* which does not leave the mine (Dyar, Proc. Ent. Soc. Wash., 1901, Vol. IV, p. 479).

When full grown, the larva leaves the mine, and spins a broadly oval cocoon, of dense, pure white, almost cobwebby silk. From the cocoon, a few frothy globules are sometimes ejected. In emergence, the pupa is not protruded from the cocoon. Pupa obtect, the first four segments fixed, followed by three movable incisures; spiracles borne on slender cones; no dorsal spines, but each abdominal segment with a pair of short curved setae ventral to the spiracles; cremaster with three pairs of hooked setae. Appendages free from the body caudad of the fourth segment; wings reaching onto the sixth segment, separated toward tip exposing posterior tarsi. Maxillae concealing the labial palpi except for a minute triangular basal piece; maxillary palpi present, but extremely minute. Antennae short, not reaching tip of exposed part of mesothoracic legs. Front legs touching antennae at base, front femora exposed.

Mining larvae may be found throughout the summer and early autumn, apparently with no definite broods distinguishable. In August and September miners of all ages may be found at the same time. Emergence of the imagoes seems to be determined by temperature conditions; a hot spell may result in emergence of some imagoes, while others remain over for varying periods. Thus the imagoes of early May and June 1 came from the same lot of larvae, collected September 3 of the preceding year, those of August 5 from larvae full-fed on July 24, the imago of September 12 from larvae collected August 19, while the rest of the pupae from this collection remained over winter. This apparent dependence on warmth for emergence results in a high mortality amongst the reared material when in the pupal state.

The natural range of the food plant, as given in Britton and Brown's Illustrated Flora is "Kentucky to Missouri, Florida and Mexico." In general the genus is of tropical distribution.

The imago rests with the hind legs elevated and prominently displayed; the wings arched with the upper surface convex, the tips of the wings curved downward. The moth more often jumps than flies; this habit, with the convex wing surface and conspicuous hind legs, gives it the aspect of a minute flea beetle.

In venation, *Cyphacma tragiae* and *C. chalcozela* agree (compare figs. 1 and 2) except that in the fore wing of *C. tragiae* (fig. 1) the cell is closed between veins 9 and 10 by an obsolescent vein (the basal portion of R$_3$). The obsolescence of the base of the radial sector in *C. tragiae* foreshadows its complete disappearance together with R$_2$ and the basal piece of R$_3$ in all species of *Cycloplasis* (figs. 3 and 4). In the hind wing, vein 6 (M$_1$) is weak in *Cyphacma tragiae*, but the evenly tapering hind wing at once distinguishes *Cyphacma* from *Cycloplasis*. Loss of this vein and the extreme narrowing of all but the base of the wings will bring about the condition seen in *Cycloplasis*. Apparently intermediate between *Cyphacma* and the two North American species of *Cycloplasis* in venation of fore wing, is the South American *Cycloplasis habrarcha* Meyrick. Figure 3, constructed from Meyrick's description of the venation of this species (Exot. Microlep., II, 64, 1917), gives my interpretation of the venation of this species based on the assumed relationship of *Cyphacma* and *Cycloplasis*. On this basis, the strong vein through the middle of the fore wing in the two North American species of *Cycloplasis* (fig. 4) is composed of the lower margin of the cell (Cu$_1$), the discal vein, and the stalk of the remaining branches of Media and Radius. In fact, in both *Cycloplasis panicifoliella* Clemens and *Cycloplasis immaculata* Braun, there is a slight irregularity or break in this vein just at the point where vein 2 (Cu$_{1b}$) would be given off (fig. 4). Hence the interpretation of the venation by Forbes (Lepidoptera of New York and Neighboring States, 1923, p. 359) is not tenable.

In palpal structure, *Cyphacma tragiae* agrees with *Cycloplasis*, and is at variance with the description given in Meyrick's generic characterization. The spines at the tip of the third segment when closely appressed together appear as a small acute segment, and may have been mistaken for the third segment. This is indicated by Meyrick's description of the third segment of the palpi in *Cycloplasis habrarcha* as very short and pointed; the third segment together with its apical spines is considerably longer than the second in *Cycloplasis*. Figure 8 shows the labial palpus of *Cycloplasis panicifoliella* with spines spread; fig. 9 with spines appressed together. Both conditions may be observed in dry specimens. Minute maxillary palpi are present in both genera.

In spining of the posterior tibiae and tarsi *Cyphacma tragiae* (fig. 7) shows a condition intermediate between *Cycloplasis* (fig. 6) and that described for *Cyphacma chalcozela*, in which the posterior tarsi are described as having "very short bristles at apex of joints," with no mention of spines on the first segment, present in *Cyphacma tragiae*.

Two more species of *Cycloplasis* not discussed here have een described: *gnathodes* Meyrick (Exot. Microlep., II, 64, 917) from Ecuador, and *basiplagata* Wlsm. (Proc. Zool. Soc. ond., 1897, p. 143) from the West Indies; no information as to ructure of either is available. The food plant of the latter given as *Sida* sp. (Malvaceae), but the larval habit as described seems doubtful; the case may be the pupal rather than the larval case, and cut from the leaf as in the grass-mining species.

The more complete venation, together with the broader and evenly tapering hind wings, the different larval habits and larval structure at once separate *Cyphacma* from *Cycloplasis*. The points of similarity, not shared by any other genera in the Heliodinidae, indicate their close relationship, and suggest the possibility of further connecting forms.

MILITARY PREVENTIVE MEDICINE, by George C. Dunham. xxvi+1198 pp., 329 illustrations, 2 colored plates. Buckram binding. Third edition. 1940. Military Publishing Co., 100 Telegraph Bldg., Harrisburg, Pa. Price $3.75.

Many biologists are now serving in our military organizations in the capacity of entomologists, and individuals with the proper training are being successful in giving service of importance, the value of which is recognized. There are entomologists and students in college, lacking the essential training, who, upon being called into service, will try to get into entomological work. This book by Brigadier General Dunham is of great importance to the latter groups. It is unique in that it gives the medical officers' conception of the relation and importance of medical entomology to other phases of preventive medicine in connection with a military force. Because of this fact alone, anyone contemplating military service as an entomologist or general sanitarian or engaged in teaching people who may do this sort of work, should study this volume with care.

Five chapters of approximately 200 pages contain brief and accurate accounts of insects and insect-borne diseases troublesome to troops. The biology and control of insects are stressed; general principles receive special attention. Since this book deals primarily with the prevention of epidemics, the protection of groups of men rather than of individuals is emphasized. There is very little information for the identification of specimens. The poisonous and venomous arthropods are not included. The chapter on rat control, a job which entomologists often find passed on to them, is worthwhile. This volume is not a comprehensive treatise on medical entomology but, as pointed out above, its value is of great importance. The price quoted was obtained from a local bookstore and we believe it is correct.—C. E. Venard.

A DESCRIPTIVE STUDY OF THE PILOTAXY OF A MODAL CULEX PIPIENS FOURTH STAGE LARVA

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This paper is a descriptive study of the larval pilotaxy of a stenogamous, autogenous strain of *Culex pipiens* from the laboratory in the department of Bacteriology and Parasitology at the University of Chicago. The study was initiated by observations on a mounted fourth instar larva which was then described and drawn. One hundred additional mounted larvae, constituting a random sample, were examined and the findings were tabulated. The result is given here as the description of the pilotaxy of a modal fourth-stage larva.

TYPES OF HAIRS

The illustration of the complete larva (figure 1) shows a number of different types of hairs. A hair may be single, unbranched; bifid, divided at the base into two branches; or tufted, divided at the base into three or more branches. An unusual dendroid type of hair, occurring in not more than four positions on the whole larva, is branched and rebranched at many points between the base and the distal end. Single hairs and branches of hair tufts vary greatly in length and thickness; they may be simple, with bare surface; barbed; or feathered. Figure 2 illustrates types of hairs.

ARRANGEMENT

The hairs of the larva are in a symmetrically paired arrangement. Only one member of each pair is described here. In figure 1 the left side shows the dorsal hairs of the head, the thorax, and the first seven segments; the right side shows the ventral hairs. A lateral view of the terminal segments is shown.

PILOTAXY OF THE HEAD

The antennae:

Projecting from the spine-studded shaft of the antenna is the antennal hair of approximately twenty heavily feathered branchings. The truncated apex bears two short subterminal setae, two short terminal bristles, and a small chitinous digit.

Dorsal head hairs:

The most anterior hair on the dorsal surface of the head is the short, stout, curved preclypeal spine. On the clypeus, the central portion of the head, the regular designation of hairs by numbers begins. These hairs are in two irregular rows. The anterior row contains the frontal hairs, numbers 2, 3, and 4, which are prominent and important for purposes of identification.

No. 1. A single, slender hair medium short in length, located near the mid dorsal line and slightly anterior to center.

Nos. 2 and 3. Stout hairs, approixmately half the length of the head, with respectively 5 and 4 feathered branchings from the base. Located slightly posterior and lateral to hair number 1.

No. 4. Similar in structure to numbers 2 and 3, with ten feathered branchings. Located anterior and lateral to numbers 2 and 3.

Nos. 5 and 6. Short, fine hairs with 2 and 3 branchings respectively. Located near the base of the head.

No. 7. A single hair of medium length, inserted laterally at the base of the eye.

Ventral head hairs:

Although the mouth-brushes may be seen in a dorsal view of the larva, they are borne by the labrum on the ventral surface. These brushes are composed of a collection of fine, long, curved hairs.

No. 1. The most medial ventral head hair, slightly posterior to center. Very short and fine with 3 branchings.

No. 2. A single, fine, short hair.

Nos. 3, 4, and 5. Numbers 3 and 5 are medium in length. Number 4 is slightly longer and stouter than numbers 3 and 5. Each has 3 branchings. These hairs follow approximately the line of the eye from posterior medial to anterior lateral margin.

PILOTAXY OF THE THORAX

The thorax is divided in hair arrangement into three segments, prothorax, mesothorax, and metathorax. Each segment contains, on the dorsal and ventral surfaces, one irregular row of hairs which includes the lateral hairs. These lateral hairs and the "shoulder" hairs on the anterior margin of the dorsal surface of the prothorax are the most prominent on the larva and are important for identification. All these hairs arise from large papillae.

Dorsum of the prothorax:

No. 1. A group of three "shoulder" hairs inserted individually but in one papilla. Very stout and barbed. These are the longest hairs on the larva. They extend from the anterior margin of the thorax to the front of the head.

Nos. 2, 3, 4, 5 and 6. Inserted in individual papillae. Similar to number 1 but only three-fourths as long. Numbers 3 and 4 are single; numbers 2, 5, and 6 are bifid. These hairs are inserted in a row which follows the contour of the anterior margin of the thorax.

No. 7. A short dendroid type tuft having a varying number of hairs, branched and rebranched from the base to the distal end.

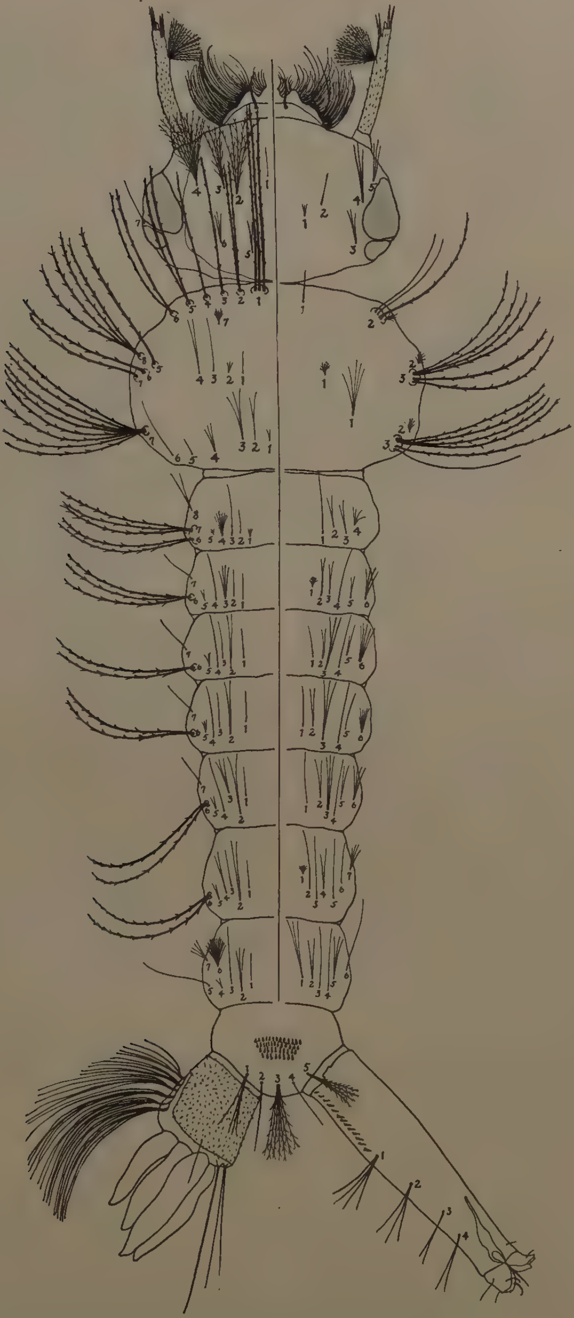
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FIG. 1. Pilotaxy of a modal *Culex pipiens* larva. The left side shows the dorsal hairs of the head, the thorax, and the first seven segments; the right side shows the ventral hairs. A lateral view of the terminal segments is shown.

Ventrad of the prothorax:

No. 1. The anterior medial hair, single, short, and slender.

No. 2. A lateral group of four hairs inserted in a large papilla. There are two medium long, slender, simple hairs; one long, stout, barbed hair; and a tuft of very short fine hairs.

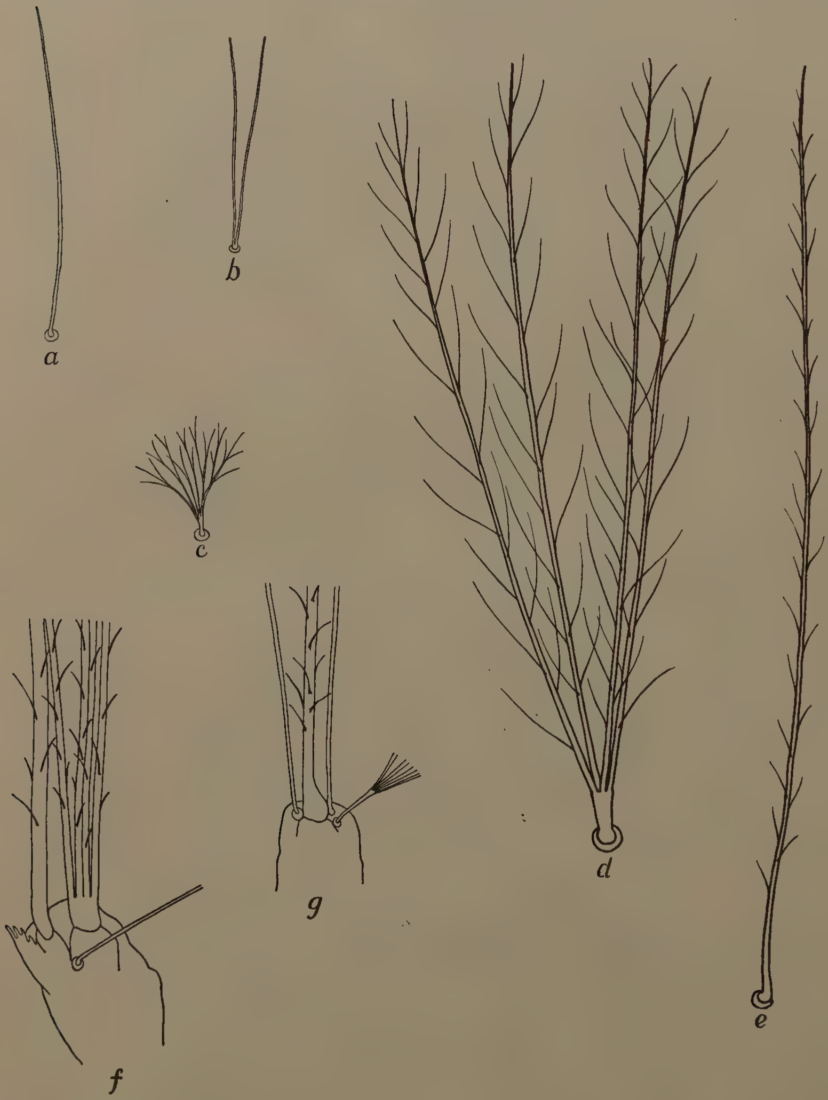

FIG. 2. Pilotaxy of a modal *Culex pipiens* larva. Various types of hairs. (a) simple hair; (b) bifid hair; (c) dendroid type hair; (d) feathered hair with multiple branching; (e) barbed hair. (f) and (g) illustrate insertions of several hairs in single papillae. The hairs illustrated in (f) and (g) are truncated.

Dorsum of the mesothorax:

Nos. 1, 2, 3 and 4 form an irregular row from the medial line to the lateral margin. Number 1 is single and short; number 2 is very short with 3 branchings; number 3 is medium in length and single; number 4 is medium in length and bifid.

Nos. 5, 6, 7 and 8 on the lateral margin are long, stout, and barbed. The first three are single. Numbers 6 and 7 are inserted in the same papilla. Number 8 has 6 branchings.

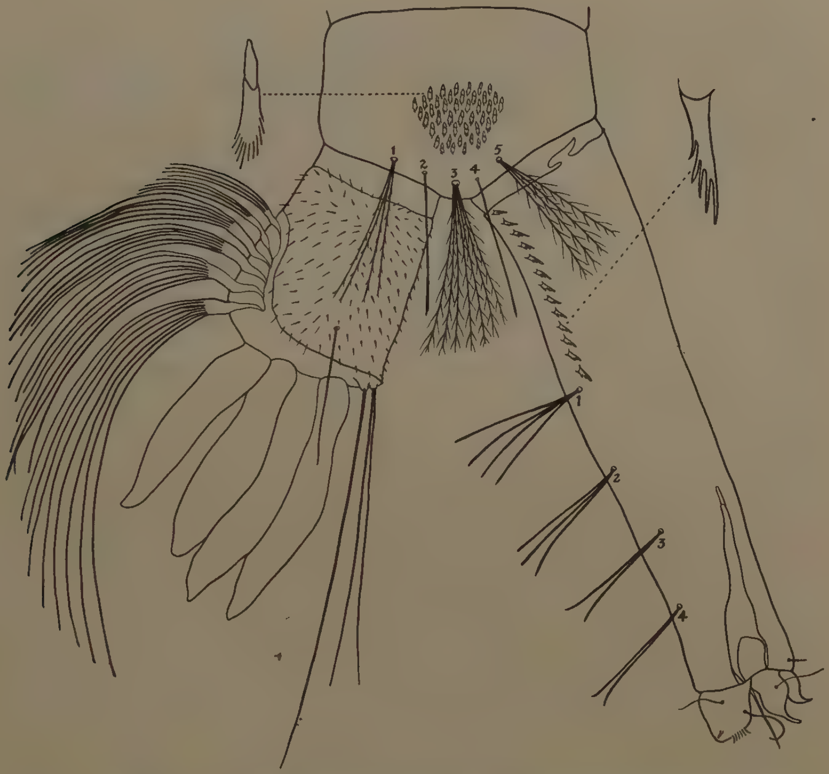

FIG. 3. Pilotaxy of a modal *Culex pipiens* larva. Lateral view of the terminal segments showing an enlarged pecten tooth and scale.

Ventrad of the mesothorax:

No. 1. Similar in all characteristics to number 7 of the dorsum of the prothorax.

No. 2. A tuft of very short, fine hairs on the lateral margin.

No. 3. A lateral group of three long, stout, barbed hairs arising from one papilla. Two are long and single; the other is slightly shorter with 4 branchings.

Dorsum of the metathorax:

Numbers 1 through 6 form an irregular row from the medial line to the lateral margin near the posterior margin of the thorax. Number 1 is very short and bifid; numbers 2 and 3 are medium in length with 2 and 3 branchings respectively; number 4 is short with 3 branchings; number 5 is single and very short; number 6 is single, slender, and medium long.

No. 7. Inserted on lateral margin. Similar to number 8 of the dorsum of the mesothorax but with 8 branchings.

Ventrad of the metathorax:

No. 1. Slender, of medium length, with 5 branchings.

No. 2. A very short tuft of numerous fine hairs.

No. 3. Three hairs arising from a single papilla at the lateral posterior margin of the thorax: one long, stout, barbed hair with 4 branchings; a similar single hair; and one single, simple, slender hair of medium length.

PILOTAXY OF THE FIRST SEVEN ABDOMINAL SEGMENTS

The dorsal and ventral surfaces of each of the first seven abdominal segments contain from 4 to 8 hairs arranged in irregular rows beginning near the medial line and being numbered consecutively from that point to the lateral margin.

Homologies between hairs of succeeding segments have been considered (Hart, 1942), and for convenience the hairs of the dorsum of segments III, IV, V, and VI and of the ventrad of segments III, IV, and V are described collectively.

Dorsum of segment I:

No. 1. A very short hair divided at the base into 3 branches.

No. 2. A short, single hair.

No. 3. Medium long, and simple.

No. 4. A brush of approximately 10 fine, short hairs.

No. 5. A very short, fine hair with 4 branchings.

Nos. 6 and 7. Long, stout, barbed hairs of 2 and 3 branchings, inserted in a single large papilla.

No. 8. Medium in length, slender, bifid.

Ventrad of segment I:

No. 1. Long, slender, single.

Nos. 2 and 3. Medium short, bifid.

No. 4. A short, fine hair with 4 branchings.

Dorsum of segment II:

Nos. 1 and 2 are short and simple.

No. 3. Divided at the base into 4 branches of medium length.

No. 4. A long, slender, single hair.

No. 5. Short, fine, bifid.

No. 6 corresponds in character and position to number 7 of segment I.

No. 7 corresponds to number 8 of segment I but is single rather than bifid.

Ventrad of segment II:

No. 1. A short hair similar in structure to number 7 of the dorsum of the prothorax.

Nos. 2 and 3. Slender and bifid. Number 2 is medium long. Number 3 is medium in length.

No. 4. Long, slender, and simple.

No. 5. Medium short, slender, bifid.

No. 6. Medium in length, slender, with 4 branchings.

Dorsum of segments III, IV, V, and VI:

No. 1. A single, short, fine hair.

No. 2. Long, slender, bifid.

No. 3. Medium in length, slender, and single except on segment V where it has 3 branchings.

No. 4. Long, slender, simple on segments III, IV, and V; bifid and somewhat shorter on segment VI.

No. 5. Very short and divided near the base on segments III and IV into 3 branches; on segments V and VI into 2 branches.

No. 6. Homologous with the corresponding hair on segment I.

No. 7 on segments III, IV, and V is homologous with the corresponding hair on segment II. This hair is not present on segment VI.

Ventrad of segments III, IV, and V:

No. 1. A slender, simple hair; short on segment III, medium in length on segment IV, and long on segment V.

No. 2. Bifid; short on segment III, medium in length on segments IV and V.

No. 3. Branched at the base into three long, slender hairs.

No. 4. Long, slender, and simple.

No. 5. Homologous to number 5 of segment II but simple rather than bifid on segment IV.

No. 6 on segments III and V is medium in length with 5 and 4 branchings respectively. Number 6 on segment IV is a short brush of from 6 to 8 hairs.

Ventrad of segment VI:

No. 1. Homologous with number 1 of segment II.

Nos. 2, 3 and 5. Long, slender, and simple.

No. 4. Bifid, medium in length.

No. 6. Simple and medium in length.

No. 7. Short and fine, divided at the base into 4 branches.

Dorsum of segment VII:

No. 1 is homologous to the corresponding hair on each of the preceding abdominal segments.

No. 2. Medium long with 3 branchings.

Nos. 3 and 5. Long, slender, single hairs.

No. 4. Homologous with number 5 on the preceding segment.

No. 6. A medium short brush, branched and rebranched near the base into from 15 to 20 hairs.

No. 7. A laterally inserted short hair of 4 branchings.

Ventrad of segment VII:

No. 1. A long slender hair with 3 branchings.
No. 2 corresponds with number 2 of segments I, IV, and V.
Nos. 3, 4, and 6 are long, slender, single hairs.
No. 5. Medium in length, divided at the base into 3 branches.

Laterad of segment VIII:

Located near the posterior margin of the eighth segment is the comb, a triangularly arranged group of scales. Each scale is somewhat rectangular in shape with one pointed end and a feathered tip. The comb consists of from 30 to 50 scales, the modal number being approximately 44.

Posterior to the comb and following the marginal line of the segment are five hairs of medium length.

Numbers 2 and 4 of this group are simple and unbranched. Number 3, the central hair, is profusely feathered and divided into 7 branches. Number 1 and number 5 each consist of 4 branches, the former having a few short barbs, the latter being feathered.

Anal segment:

The anal segment is completely encircled by a sclerotised, spicule-covered plate called the saddle. From this plate, near the posterior dorsal margin, extends a single medium long hair, the saddle hair.

The two conspicuous groups of hairs, the ventral and dorsal brushes, are located outside the saddle. The ventral brush consists of an irregular row of 5, 6, or 7 tufts, branched and rebranched into numberous hairs. The tufts vary in length, becoming progressively longer toward the posterior end of the segment.

The dorsal brush includes one very long, stout, single hair and another slightly shorter and more slender hair which usually has 2 branches. Both hairs arise from large papillae.

Siphon:

Ranging posteriorly from the base of the siphon is a longitudinal, ventro-laterally placed row of teeth collectively constituting the pecten. These are 13 in number, triangular in shape with a dentated edge, and are obliquely inserted. Also on the ventro-lateral surface of the siphon are four hair tufts of medium length. Number 1 has 4 branches, number 2 has 3 branches, numbers 3 and 4 each have 2 branches. Situated dorsally near the tip of the siphon is the very short apico-dorsal hair. At the apex of the siphon are five valves; a small medio-dorsal valve, paired dorsal valves, and a pair of larger ventral valves. On each ventral valve is one fine, unbranched hair located proximally, and at the distal end a short hooked spine. In some cases this valve also contains, near the distal end, a short, blunt, spine-like digit. There is a short, fine, unbranched hair on each dorsal valve. These five valves are hinged basally to the stirup-shaped piece within the siphon. From this piece a tapering spine-like projection extends posteriorly approximately twice the length of the valves.

REFERENCE

Hart, Thomas A. 1942. The Larval Pilotaxy of *Culex pipiens* with Special Reference to Genetics. Annals Entom. Soc. Amer., 35: 141–152.

REARING OF THE DAMSEL FLY, ISCHNURA VERTICALIS SAY, IN THE LABORATORY

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The successful rearing of the naiads of Odonata has been accomplished by a number of workers; apparently the life cycle having been determined for about 18 species (Bick, 1941). Eight of these are members of the suborder Zygoptera or damsel flies.

Most workers in rearing naiads of Odonata have had relatively high death rates, particularly in the later instars. The writers were so successful in rearing the naiads of *Ischnura verticalis* throughout the greater portion of their development that it was thought worth while to describe their methods. These naiads were probably in the third or fourth instar when first observed, and were introduced when very small in a clump of grass that was collected from an overhanging bank of a pond. This species has been reared through its complete life cycle by Grieve (1937). Balfour-Browne (1909) has described the life history of *I. elegans* in England.

A general study of suitable methods for rearing aquatic insects was being made. The naiads of *Ischnura verticalis* were placed in a wooden aquarium (11″ x 30″ x 8″) and reared together. Pond water was used and maintained at a depth of two to four inches. The bottom was covered with sand and the top was open. A clump of grass was growing in one end. Fine bubbles of air were continuously liberated through a porous disk near the center of the aquarium. This kept the water saturated with oxygen and produced sluggish currents that prevented an accumulation of dust and microscopic growth on the surface. The room temperature was fairly constant and the water temperature remained near 16° C.

Apparently the naiads were hungry when first found, as attempts at cannibalism were observed, but they discontinued such efforts after hand feeding started. They scattered throughout the aquarium clinging to the wooden walls and usually kept well distributed. At times several of them would return to the clump of grass, but this did not affect their willingness to accept proffered food. It is not known whether the naiads succeeded in capturing any natural food in the aquarium, as little such food was observed.

We were rearing large numbers of house fly maggots at the time for other experiments and used these as food; small larvae or bits of larvae being offered at first, and larger maggots being offered as the naiads developed. At no time were the naiads, even when nearly mature, willing to accept maggots more than half grown, but they readily accepted fragments of the larger maggots, if these still wriggled. The maggots were held with a forceps and placed directly in front of the damsel flies. The naiads usually retreated if the struggling maggot touched them before they attempted to capture it. For a few minutes following this they were less likely to accept the proffered food. Immediately on grasping the maggot, the naiads moved backward and if the food was not quickly released from the forceps they would often abandon their prey. Maggots were not left in the aquarium if refused by the naiads. Food was offered every other day, after a few trials, since they seldom would accept food oftener. On the other hand, they seldom refused food on the second day. Similar techniques were used with immature stages of dragon flies, stone flies, caddice flies, and adult hydrophilids. The caddice flies were most difficult to feed, since they retreated into their cases unless approached cautiously or when touched.

The naiads crawled on the sides of the aquarium to emerge. Eight of the nine original naiads emerged between March 11 and May 15, one having died previously.

The low mortality and lack of cannibalism among our naiads suggests that the environment was very satisfactory. Maggots of *Musca domestica* L., while non-aquatic, were acceptable and satisfactory food. The temperature of the water remained near 16° and probably did not exceed 18° C. The water was saturated with oxygen at all times, and at a temperature of 16° would contain an abundant supply. Since many workers have reported high mortalities of naiads in the later stages, when reared in small containers at room temperature, it is probable that our success was closely related with temperature. Cannibalism, so frequent in small containers, was not a factor in our studies.

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SYNONYMS OF FORMICA DIFFICILIS EMERY (HYMENOPTERA: FORMICIDAE)[1]

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In 1939, I described as new the ant, *Formica habrogyna*. Some time after that a formicologist wrote me that he considers *habrogyna* to be a synonym of *difficilis* var. *consocians* Wheeler. Upon further study of long series of all castes of *habrogyna* and comparisons of them with topotypes of *consocians*, kindly sent to me by the American Museum of Natural History, I have arrived at an opinion that although *habrogyna* is undoubtedly identical to *consocians*, *consocians* is also well within the limits of specific variation of *difficilis*.

Although apparently there were, in the U. S. National Museum, numerous workers and a number of males and females of *difficilis* which had been collected at the type locality by Pergande and which might even represent a part of the type series, Wheeler established *consocians* after having compared his specimens with a single female from Virginia, two badly rubbed workers from New Jersey and a long series of workers and one deälated female collected in North Carolina. Since he based the variety primarily on a greater pilosity, it is easy to understand his overlooking such a variable character as pilosity in *difficilis*. Wheeler was apparently erroneously led to believe, therefore, that *consocians* is more hairy than *difficilis*.

Mr. W. F. Buren has informed me that he has compared metatopotypes of *habrogyna* with a worker and a female (possibly from the original type series) collected at Rosslyn, Virginia, by Pergande. He states that the specimens of *difficilis* are definitely more pilose and pubescent than are the metatopotypes of *habrogyna* with which he compared them.

Because of the great variability in pilosity of *difficilis*, and since there are no characters of sufficient significance for separating *consocians* and *habrogyna* from *difficilis*, I am, therefore, of the opinion that both *consocians* and *habrogyna* should be relegated to the synonymy which is as follows:

Formica difficilis Emery

F. pallidefulva Mayr (*nec* Latreille), 1866, Vehr. Zool. bot. ver. Wien, 16: 889.
F. rufa subsp. *difficilis* Emery, 1893, Zool. jahrb. Syst., 7: 651.
F. difficilis Wheeler, 1904, Bull. Amer. Mus. Nat. Hist., 20: 306, 348.
F. difficilis var. *consocians* Wheeler, 1904, Bull. Amer. Mus. Nat. Hist., 20: 371; *loc. cit.*, 1906, 22: 50; 1913, Bull. Mus. Comp. Zool., Harvard Univ., 53: 479–480.
F. habrogyna Cole, 1939, Amer. Midl. Nat., 22: 413–417; *loc. cit.*, 1940, 24: 76–77.

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[1] Contribution No. 6, Department of Zoology and Entomology, University of Tennessee, Knoxville.

TWO NEW BUPRESTIDAE (COLEOPTERA)

J. N. Knull,
The Ohio State University

Chrysobothris ephedrae n. sp.

Male—Size and form of *C. deleta* Lec., robust, front bronze, clypeus, vertex, pronotum and scutellum metallic green, elytra cupreous, becoming more brilliant toward apices, legs and ventral surface bronze, pubescence moderate throughout.

Head convex; clypeus broadly emarginate; surface coarsely punctured, median line on occiput; antennae not extending to middle of pronotum when laid along side, serrate from the fourth joint.

Pronotum convex, slightly wider at base than apex, widest back of middle; sides broadly rounded from base to apex; disk convex; surface more coarsely punctured than head, small raised smooth area in front of scutellum and one each side in front of middle. Scutellum triangular, glabrous.

Elytra wider than pronotum; sides constricted back of humeri expanded back of middle, then narrowed to rounded apices, serrulate back of middle; disk convex, basal depression each side; surface densely punctured, punctures same size as on head.

Prosternum with short broad lobe. Abdomen confluently punctured, transverse smooth areas along anterior margins of third, fourth and fifth segments, irregular raised areas along sides of first four segments, last segment serrulate along sides, broadly emarginate at apex. Anterior femur with very small tooth, tibia arcuate, dilated at apex, lacking a tooth.

Length 7.5 mm.; width 2.8 mm.

Female—Last abdominal broadly rounded at apex.

Holotype male, allotype and paratypes from Las Cruces, N. M., May 12, 1941; paratypes from Texas: Pecos Co., May 8, 1941; Culberson Co., May 10, 1941, and Hudspeth Co., May 11, 1941. All material collected by D. J. and J. N. Knull from the foliage of Mormon tea (*Ephedra*) in which the species probably breeds. Type material in writer's collection.

This species should be placed next to *C. cupreohumeralis* Van D. according to Fisher's key.[1] The brilliant cupreous elytral apices will distinguish it from all related species.

Agrilus diospyroides n. sp.

Male—Size, form and color of *A. otiosus* Say, elytra and ventral surface black, antennae, legs, head and pronotum aeneous varying to green, pubescence inconspicuous.

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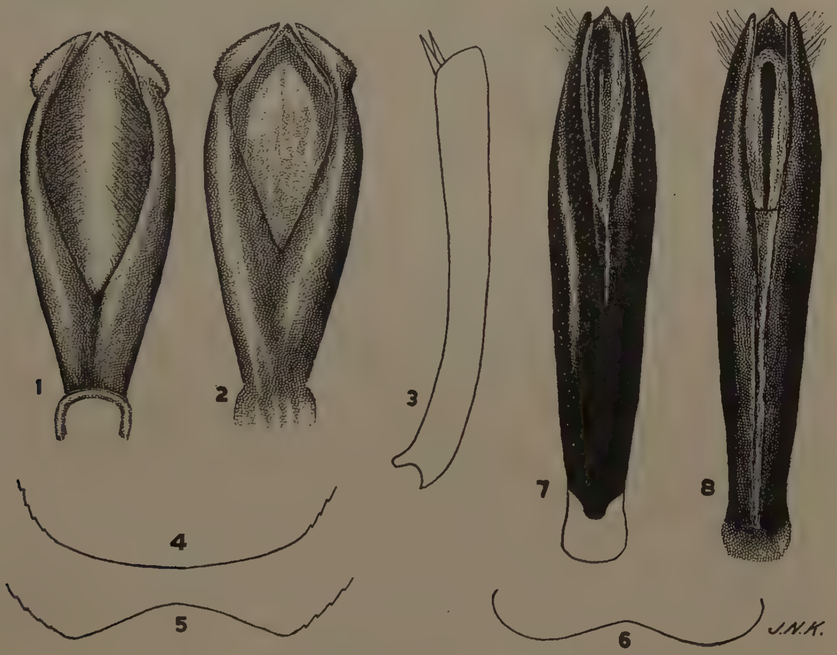
[1] W. S. Fisher, U. S. D. A. Misc. Pub. 470, pp. 1–274, 1942.

Head granulose becoming longitudinally rugose on occiput, slight indication of median depression; antennae not reaching to hind angles of pronotum when laid along side, serrate from the fourth joint.

Pronotum wider than long, widest in middle, as wide at base as in front; anterior margin strongly sinuate, median lobe broadly rounded; basal margin bisinuate, median lobe feebly produced; sides broadly rounded from base to apex, not sinuate; when viewed from the side, marginal and submarginal carinae joined at base; disk convex, two depressions along median line, lateral depressions well marked, prehumeral carinae well developed; surface feebly transversely rugose, granulose toward sides. Scutellum transversely carinate.



Chrysobothris ephedrae n. sp.

1. Dorsal view male genitalia. 2. Ventral view male genitalia. 3. Male anterior tibia. 4. Last visible abdominal sternite of female. 5. Last visible abdominal sternite of male. 6. Clypeus.

Agrilus diospyroides n. sp.

7. Dorsal view male genitalia. 8. Ventral view male genitalia.

Elytra at base wider than base of pronotum; sides parallel at base, constricted about middle, broadly rounded to rounded serrulate apices; disk flattened, basal depressions well marked; surface granulose.

Abdomen beneath lightly punctured, first two segments crenulate, flattened along median line, last abdominal rounded. Prosternal lobe broadly emarginate in front. All tibiae mucronate on inside at apices.

Tarsi on posterior pair of legs much shorter than tibiae, first joint as long as four following joints taken together, claws on all feet cleft, the outer tooth acute at apex, the inner one broader, turned inwards, the points touching.

Length 5.9 mm.; width 1.6 mm.

Described from four male specimens collected from the foliage of persimmon (*Diospyros virginiana* Linn.) in the Great Smoky Mountain National Park, Tenn., June 11, 1942, by D. J. and J. N. Knull, in the collection of the writer.

According to Fisher's key[2] this species would run to *A. frosti* Knull. It can be separated by the larger size, emarginate prosternal lobe and structure of the male genitalia.

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[2] W. S. Fisher, U. S. National Mus. Bul. 145, pp. 1–347, 1928.

ATLAS OF THE SCALE INSECTS OF NORTH AMERICA, by G. F. FERRIS, 1942. Fourth Series, Nos. 385–444 (60 pls.), concluding the Family Diaspididae. 11 x 8.5 inches. Published by the STANFORD UNIVERSITY PRESS, Stanford University, Calif. Price, bound, $6.75; unbound, $5.75.

This volume of the notable publication by Dr. Ferris, issued in 1942, includes numbers 385 to 448 with table of contents and index and constitutes what may be the final volume of the series. As in earlier parts the method of arrangement, descriptions and plates is so as to facilitate ready comparison and the work must be considered as a very essential contribution to the studies of this important group of insects. In this family the characters of the female pygidia are of fundamental importance and are given specially complete representation in the illustrations and also detailed descriptions along with discussion of synonyms, hosts and distribution habit, recognition characters and notes dealing mainly with matters relating to earlier descriptions. Naturally as an "atlas" the illustrations have a most important function and it is easy to praise the admirable drawings as also the very successful reproduction of the plates. It is a far cry from the beautiful steel engraving which accompanied Signoret's "Essai Sur Cochenilles," 1870–'75, in which the pygidia were established as important characters and the Comstock articles in the early 80's, when these features were introduced to the American students, to the elaborate drawings by this author.

The general index covering series I to IV makes available reference to all the preceding parts. While it is easy to compliment the work without stint it seems that the work might have been more acceptable to workers in general if it could have been issued in book form, thus avoiding a repetition of title pages for every number, but the cost of publication must be taken into account. As it is, the author has evidently contributed financially very largely and his work must be considered in great degree a labor of love and not of personal profit.

In his epilogue referring to the probability that the work must be discontinued he states that if it is eventually continued the loose leaf form will be abandoned and a different procedure will be adopted. Stating that he stands ready to continue the work involved, he says, "If the world wants this Atlas of the Scale Insects of North America completed the world must find some way to pay for it."—HERBERT OSBORN.

THE LARVAE OF THE SUB-FAMILY ORPHILINAE AND THEIR BEARING ON THE SYSTEMATIC STATUS OF THE FAMILY DERMESTIDAE (COL.)

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In a recent paper I have discussed at some length the larval systematics of the sub-families of the *Dermestidae*. At the time I had not seen larvae of *Orphilinae*, nor had these been previously described, so I did not mention them.

Quite recently M. P. DE PEYERIMHOFF most kindly sent me four specimens of larvae, which he had raised and which proved to be *Orphilus niger* Rossi. The larvae are of more than ordinary interest as regards the exact position of the *Dermestidae* in the order *Coleoptera* and it appeared advisable to describe them.

The larvae studied were full grown and had been found in wood of *Quercus mirbechi*, in the forest of Mouzaia, (Algiers) Sept. 3, 1940 by M. P. DE PEYERIMHOFF. Eight specimens had been collected, of which four were sent to me.

DESCRIPTION OF THE LARVA

(Figs. 1–10)

Length, 6.5–7.25 mm.

Body cylindrical, rather elongate, dark brown on the sclerites, intersegmental membranes lighter. The whole sclerotized part of the body is covered with a close, regular, uniform, double pubescence; numerous short, thick curled setae and much longer finer setae, straight and rather sparse. All the setae are simple and there is no approximation to the complex setae which usually distinguish the *Dermestidae*.

Head short, broad, mutant; ocelli not visible; epicranial suture indistinct, sutures between labrum, clypeus and frons very visible. Labrum broad and short, its anterior margin completely covered with strong, short, truncate setae. Epipharynx with two oblique sclerified bands and between them with a transverse line of sensorii; two sensorii distally to this line. Antennae (fig. 1) very short, inserted inside the mandibles at the lateral angles of the clypeus, three-jointed, the distal joint with a stiff terminal bristle, the penultimate joint bearing a strong hyaline supplementary process.

Mandible (fig. 10) nearly straight on the caudal aspect, where it is distinctly setigerous at base; molar lobe very strongly tuberculate; apex bidentate; rostral aspect with a large, obtuse and feebly sclerotized retinaculum.

Maxillae (fig. 3) of the usual Dermestid type; palpus three-jointed, the last joint the longest, palpifer very distinct; galea without hooks, densely setiferous; lacinia with a long, slender, bidentate terminal hook.

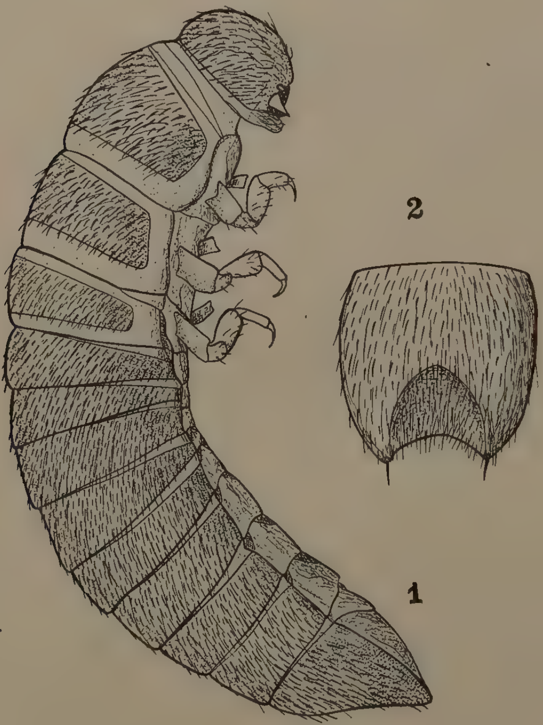
Labial palpus (fig. 6) two-jointed, the apical joint longer than the proximal joint which is strongly setiferous.

Hypopharyngeal bridge (fig. 5) very complex.

Thoracic segments posteriorly shorter; the tergum with a single sclerite; the sternum with no distinct sclerite.

Legs (fig. 8) short, rather stout and soft; coxae distant and exerted tarsal claw long, slender, strongly curved and with enlarged basis.

Abdomen nearly completely sclerified on the dorsal aspect.



Figs. 1 and 2. *Orphilus niger* Rossi. 1, Lateral view of body. 2, Dorsal aspect of the ninth abdominal segment.

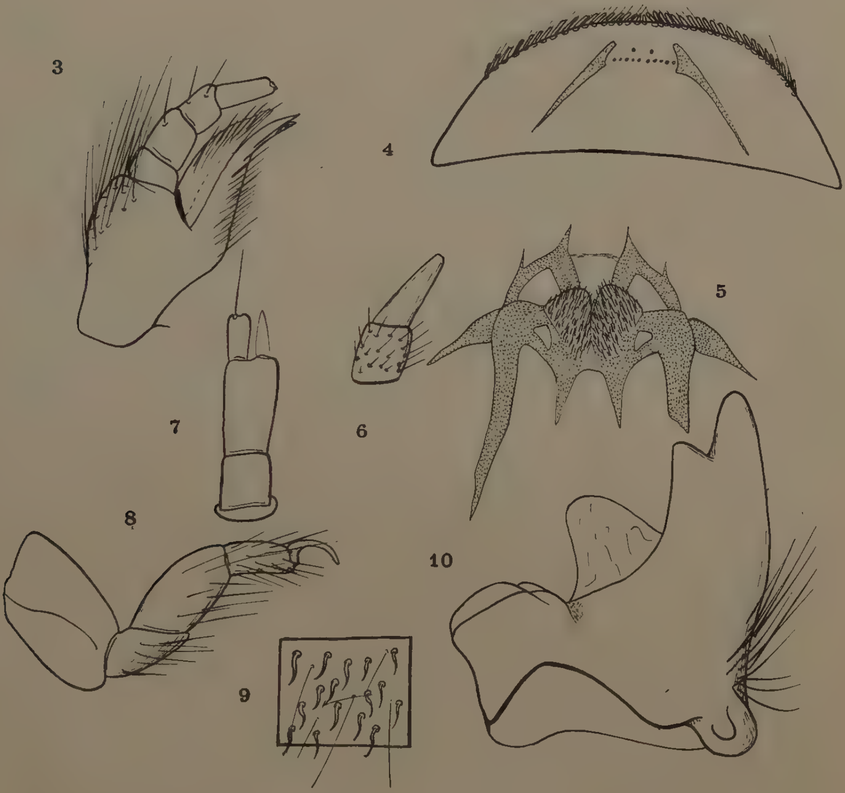
The pleural lobes not very distinct. Ninth segment rather long, its apical margin deeply sinuate, the apical angles well marked, each with a stiff and short bristle. Posterior third of the dorsal aspect of the segment excavated between the apical angles.

SYSTEMATIC POSITION OF THE LARVA OF ORPHILUS NIGER ROSSI

The sub-family *Orphilinae* groups about a dozen species known from Europe and the temperate parts of North and South

America. The Coleopterum Catalogus places this sub-family at the end of the *Dermestidae*, considering it, then, as being the most highly differentiated of all the family.

By its labrum, epipharynx, antennae, maxillae and labium this larva belongs decidedly to the *Dermestidae*, and by the characters previously used for the systematic of the family, i. e., the entirely setiferous front margin of the labrum and the urogomphi, it should rank as a distinct sub-family.



Figs. 3–10. *Orphilus niger* Rossi. 3, maxilla. 4, epipharynx. 5, hypopharyngeal bridge. 6, labial palpus. 7, antenna. 8, anterior leg. 9, detail of the pubescence of the prothoracic tergite. 10, mandible.

But the general body shape and the quite simple pubescence are unique in the family and bring to mind certain sections of the *Cucujoidea*.

The most remarkable organs of this larva are its mandibles. In all the *Cleroidea* (of which the *Dermestidae* are a family) as far as they are known, the mandible is without molar lobe and without retinaculum. The mandible of *Orphilus* on the contrary has both a retinaculum and a molar lobe and bears evident affinities with the mandible of the primitive *Cucujoidea* such as *Nitidulidae* and *Languridae*. The peculiar body shape, with its excavated dorsal aspect of the ninth abdominal segment, though evidently it may be of an adaptative nature, is also much nearer to the body shape of the *Cucujoidea* than to that of the *Cleroidea*.

So it seems that the *Orphilinae* should be placed at the head of the *Dermestidae* and that they are a distinct link between the *Cucujoidea* and the *Cleroidea*. With the knowledge that most real Dermestid larvae are saprophagus it is not possible to consider the difference between the mandibles of *Orphilus* and of (f. i.) *Dermestes* as being of adaptative origin. Though the body shape may suggest a far-off analogy with the *Byrrhoidea* the anatomical data are completely against such a relationship. It appears also that the differences in the mandibles between *Cleroidea* and *Cucujoidea* are not of constant occurrence.

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THE SKELETO-MUSCULAR MECHANISMS OF THE HONEY BEE, by R. E. Snodgrass. 1942. Pages 1–120, 32 figs. 6½ x 9½ inches. Published as No. 2 of Volume 103, Smithsonian Miscellaneous Collections. Paper bound. Price from Smithsonian, 55 cents.

Snodgrass in America and Hermann Weber in Germany are responsible for the present method in the study of the insect skeleton, the method of considering the skeletal parts as one element in a unit system, the skeleto-muscular system. Any comparative anatomy must consider both skeleton and muscular system. Sutures and sclerotic unit areas had been the criteria in such comparative studies. Snodgrass and Weber put the comparative anatomy of the insect skeleton on a determination of parts by the insertions of the muscles associated with the various parts. The function identified the structure.

Snodgrass has worked on the anatomy of the honey bee for years. This volume summarizes his work in the skeleto-muscular system and as such is in more detail than his previous accounts. It is fully illustrated. The advertisement above lists 32 figures. Each of these "figures" is compound. The actual total is 239.—C. H. K.

DEVELOPMENT OF THE FEMALE REPRODUCTIVE SYSTEM IN RHAGOLETIS POMONELLA WALSH

(DIPT.: TRYPETIDAE)[1]

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Although metamorphosis has been studied more intensively in the Diptera than in most orders of insects, comparatively little is known of the development of the secondary reproductive organs during the pupal period. A comprehensive study of metamorphosis of the sex ducts in both sexes of the blowfly, *Calliphora erythrocephala*, was published by Brüel (1) in 1897, who cited the works of Weismann (8), Künckel d'Herculais (3), Pratt (6) and Lowne (4) as comprising the literature on this subject at that time. Since then, Metcalfe (5) has described the formation of the female gonoducts in a cecidomyid, *Dasyneura leguminicola*, but there has been no work on the higher Diptera since that of Brüel, and none at all on the trypetids. The apple fruit fly, *Rhagoletis pomonella*, offers a typical example of the specialized female reproductive system found in this family. The writer has redescribed the adult structure (2) and this paper is presented as a continuation of that study.

THE INTRAPUPARIAL PHASES

The pupal period is much longer in *R. pomonella* than in the species studied by previous investigators, in which it lasts but a few days or weeks. The apple fruit fly overwinters as a pupa, remaining in this stage for nine to twelve months, with some individuals pupating for more than two years. The length of this period, coupled with wide individual variation in the developmental rate, even under similar conditions, necessitates the use of some index of development other than age. Fortunately, there are a number of fairly distinct morphological phases exhibited during the intrapuparial period and these, together with the approximate age of the individual, indicate the stage of metamorphosis to which the individual has attained. These phases may be sharply delimited by a molt or may pass more gradually into one another. Examination of a large number of pupae has disclosed few in intermediate stages, which seems to indicate that the transition from one phase to the next is rapid.

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The early intrapuparial phases have been described by Snodgrass (7). They comprise the *fourth larval instar*, the *cryptocephalic pupa* and the *phanerocephalic pupa*, the last showing two subphases—an early *microcephalic* condition of doubtful validity, and a later *macrocephalic* phase in which the pupa overwinters. Development recommences approximately one month before emergence of the adult, or about May 15 for the earliest individuals. At that time, the forming body wall and appendages of the adult become visible through the pupal integument and a phase, which the writer proposes to call the *teleomorphic*, is reached. This is the earliest stage in which the sex of the individual can be determined by casual observation, the external genitalia first appearing at this time. About two weeks later, pigmentation of the compound eyes indicates the attainment of the *chromoptic* phase and finally, about one week before emergence, the *chromogenic* phases occurs with the pigmentation of the body wall, wings and setae. The approximate ages at which the various intrapuparial phases occur are as follows:

1. Third instar larva leaves the fruit in which it has fed.
2. 12th hour—Puparium formed.
3. 24th hour—Molt to fourth instar larva.
4. 2d day—Molt to pupal stage (cryptocephalic phase).
5. 3d to 5th day—Phanerocephalic (macrocephalic) phase, the overwintering pupa.
6. 1 month before emergence—Teleomorphic phase.
7. 2 weeks before emergence—Chromoptic phase.
8. 1 week before emergence—Chromogenic phase.
9. Emergence of adult.

METAMORPHOSIS

Metamorphosis of the reproductive system involves the development of two distinct groups of organs, the gonads and the gonoducts. The former are entirely mesodermal in origin while the latter are primarily ectodermal but include some mesodermal structures. It will be more convenient to consider each group separately, while bearing in mind that their development is simultaneous. Arising from distinct histoblast groups in widely separated parts of the body, the gonads and gonoducts do not unite until metamorphosis is nearly complete. They may, therefore, be treated independently of one another without confusion.

DEVELOPMENT OF THE GONODUCT SYSTEM

This section deals with the formation of the greater part of the reproductive system—the oviducts, bursa copulatrix, spermathecae, accessory glands, vagina and ovipositor. Unlike the gonads, these organs are not found in the embryo, even as rudiments, but appear only after the beginning of larval life. Their metamorphosis is, in effect, a sort of delayed embryonic development.

First instar larva. There are no rudiments of the secondary sex organs present in the first larval instar, but a thickening of the epidermal cells around the anus, in the region where the histoblasts of the sex ducts later develop, probably indicates a specialization of these cells for the formation of the rudiments.

Second instar larva. The three histoblasts from which arise the gonoducts of both sexes are first found in the second instar larva. During the larval and earliest pupal stages there are no features which permit ready distinction between the male and female rudiments, so that the following descriptions apply equally well to either sex.

Immediately before the junction of the distal end of the rectum with the ventral body wall in the last larval segment is a small, transversely elongated and dorso-ventrally flattened histoblast (*M Hbl*) with a smaller, spheroidal histoblast (*L Hbl*) near either end. All three are attached to the inner surface of the body wall, the median histoblast at its middle and the lateral rudiments by one end. The latter are typical invaginated imaginal discs, but the median histoblast is a double structure, composed of two invaginated discs united at their points of attachment to the body wall. There are thus four discs giving rise to the sexual ducts. This corresponds to the number of rudiments found in *Volucella* by Künckel d'Herculais, but in that insect all four are separate. The condition in *Calliphora*, as reported by Brüel, is similar to that in *Rhagoletis*.

In section, the histoblasts are seen to be sac-like. The dorsal walls of the sacs are thickened to form the imaginal discs, and, in the lateral histoblasts, almost completely fill the peripodial cavities. The discs in the median histoblast are at its free ends, the middle portion being thinner walled. Peripodial stalks are lacking. There are no interconnections between the histoblasts, nor any with the gonad rudiments, which are a considerable distance away from them. The walls of the rudiments are formed by a single layer of elongated cells with conspicuous nuclei, and are covered by a thin, structureless membrane which is probably a basement membrane. The peripodial cavity is lined with an intima continuous with the cuticular layer of the body wall. This is quite conspicuous in the lateral rudiments but is much reduced in the median histoblast.

Third instar larva. The rudiments of the reproductive organs in the third instar larva are similar to those of the second instar but considerably larger (figs. 1, 2 and 9). The double median histoblast, in particular, is flattened medially, while those parts of the sac wall which form the imaginal discs are markedly thicker. From the free ends of the sac, slender cellular strands extend forward a short distance and then appear to unite with muscles of the body wall. Similar structures in *Calliphora* are said, by Brüel, to unite with the epithelium of tracheal branches, but such connections could not be seen in *Rhagoletis*.

Fourth instar larva, cryptocephalic and microcephalic pupae. After formation of the puparium, the rudiments of the secondary sex organs begin to enlarge and develop. The imaginal discs become more distinct as the thinner periblastic parts of the histoblast walls separate from them and bulge outward. An opening appears at the point of attachment to the body wall and enlarges until the imaginal discs come to lie on the surface of the body as the entire histoblast flattens out (figs. 3 to 8). The lateral discs are also everted in the same manner, and unite with the median discs so that, together, they form a thickened, roughly crescentic or semicircular papilla of elongated cells just before the anus. This structure is visible externally as the *genital plate* (figs. 12 to 14). Three pairs of small invaginations appear in it, arranged one immediately behind the other along the median line. The most anterior of these are the rudiments of the lateral oviducts, the second pair forms two of the spermathecae, while the last pair gives rise to the accessory glands. The rudiments are composed of a single cell layer, or perhaps an aggregate of cells forming only one distinct layer. In sections, the most conspicuous cytological elements are the almost solid masses of nuclei. In addition, there is a small mass of cells capping the spermathecal and accessory gland rudiments and forming a second tissue layer above them. (fig. 10, *Mes*).

Early macrocephalic pupa. Early in this stage, the sex of the pupa becomes discernible. In the male, a single, large internal projection forms on the genital plate, instead of three pairs of smaller rudiments. Descriptions of succeeding stages apply only to the female.

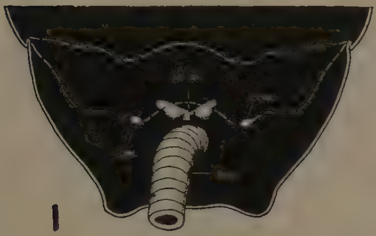
Explanation of Plate I

Fig. 1. Histoblasts of the gonoduct in a third instar larva, dorsal aspect of caudal end of body. × 30.
Fig. 2. Median histoblast of third instar larva, lateral aspect. × 100.
Figs. 3 to 8. Schematic stages in flattening out of the median histoblast during the fourth larval instar, lateral aspect. × 100.
Fig. 9. Longitudinal section through a lateral histoblast of the same third instar larva as in fig. 2. × 100.
Fig. 10. Sagittal section through the genital plate of an early macrocephalic pupa. × 100.
Fig. 11. Sagittal section through the genital plate of an overwintered macrocephalic pupa. × 100.
Fig. 12. Posterio-ventral aspect of the end of the abdomen of the same pupa as fig. 10, showing external appearance of the genital plate. × 50.
Fig. 13. External appearance of the genital plate of a macrocephalic pupa 12 days after formation of the puparium. × 50.
Fig. 14. External appearance of the genital plate of a macrocephalic pupa slightly more advanced than fig. 13. × 50.

Abbreviations Used in the Plates

Ac Gl—Accessory gland.
An—Anus.
Clo—Cloaca.
Cu—Cuticula.
Epid—Epidermis.
Ft Cls—Fat cells.
G Cls—Germ cells.
Hbl Epid—Epidermis derived from histoblast.
In Cls—Interstital cells derived from peripheral layer.
Is G—Intersegmental groove.
L Hbl—Lateral histoblast.
L Ovd—Lateral oviduct.
Mem—Membrane.
Mes—Mesoderm.
M F—Marginal fold.
M Hbl—Median histoblast.
M Ovd—Median oviduct.
Mus—Muscle.
Ov—Ovary.
Ovl—Ovariole.
Ovp—Ovipositor.
Ped—Pedicel.
Per Cls—Cells of peripheral layer.
Phr—Phragma.
Pp C—Peripodial cavity.
Prt Mem—Peritoneal membrane.
Pu—Puparium.
Rec—Rectum.
Sh—Sheath of ovipositor.
Sp—Spiracle.
Spt—Spermatheca.
T Fil—Terminal filament.
Tr—Trachea.
Vag—Vagina.
V Rcp—Ventral receptacle.

Roman numerals refer to abdominal segments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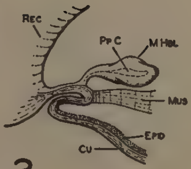
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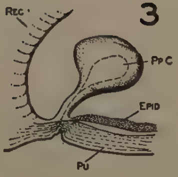
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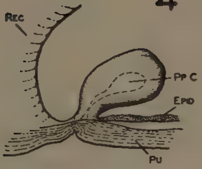
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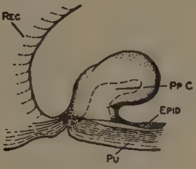
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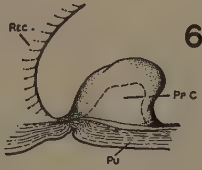

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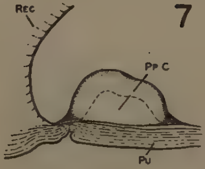

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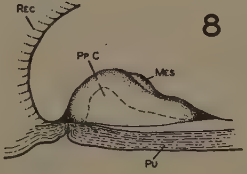
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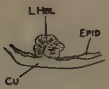
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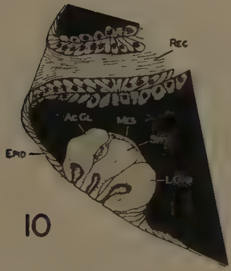
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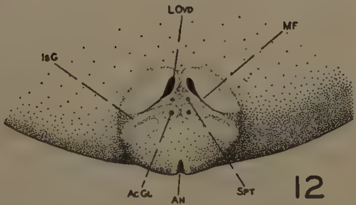
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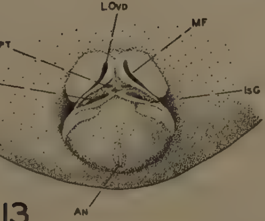
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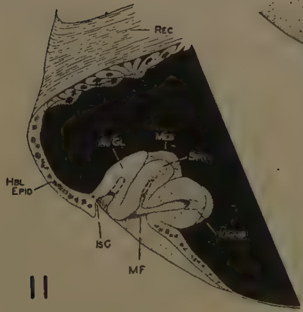
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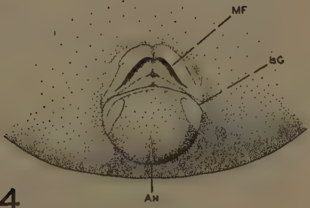

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The paired invaginations increase in size, forming fingerlike projections on the inner surface of the genital plate (fig. 10). At the same time, a transverse fissure appears on its outer surface, immediately behind the accessory gland rudiments (figs. 12 to 15, *Is G*). This is the beginning of the intersegmental groove between the eighth and ninth abdominal segments. Similarly, marginal folds (*M F*) converge forward from the ends of the intersegmental groove to the openings of the lateral oviducts, and with it delimit a triangular area within which the three pairs of openings of the rudiments lie.

Middle macrocephalic pupa. The area covered by the genital plate increases, its cells replacing those of the pupal epidermis (fig. 11, *Hbl Epid*). The ends of the crescentic plate grow dorsad, surrounding the anus and uniting above it. At the same time, an imaginal disc in the anus itself begins to develop, and eventually unites with the genital plate, which now assumes an almost circular shape (fig. 15). The intersegmental groove also lengthens dorsally, its ends finally uniting above the anus and delimiting the ninth abdominal segment of the adult (fig. 17). Meanwhile, the marginal folds have met at the apex of the triangular area containing the paired openings of the internal rudiments, and this whole area begins to invaginate, being carried into the body by the anterior elongation of the rudimentary median duct (figs. 11 and 14 to 17).

Late macrocephalic pupa. The genital plate enlarges considerably and a second intersegmental groove, starting on the dorsal surface and lengthening ventrally, appears anterior to the now completed ninth segment (fig. 19). This groove delimits the disc-like eighth abdominal segment (fig. 20). The ninth segment has assumed a trilobate form, with the anus opening on the middle lobe. The lateral lobes enlarge and grow out beyond it, so that the anus no longer opens on the extreme posterior tip of the body (figs. 17 to 22). Meanwhile, the median duct has continued to elongate anteriorly within the abdomen, the three pairs of tubular

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EXPLANATION OF PLATE II

Fig. 15. External aspect of posterio-ventral surface of the abdomen of the same pupa as fig. 11. × 50.

Fig. 16. External aspect of the posterio-ventral surface of the abdomen of a late macrocephalic pupa. × 50.

Fig. 17. External aspect of the posterio-ventral surface of the abdomen of a late macrocephalic pupa. Marginal folds united with the intersegmental groove delimiting the ninth abdominal segment. × 50.

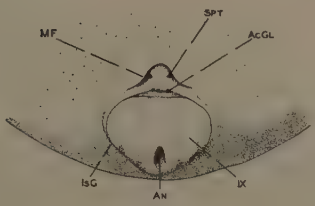
Fig. 18. External aspect of the posterio-ventral surface of the abdomen of a late macrocephalic pupa, slightly more advanced than fig. 17. × 50.

Fig. 19. External aspect of the posterio-ventral surface of the abdomen of a late macrocephalic pupa, showing partial development of the second intersegmental groove. × 50.

Fig. 20. External aspect of the posterio-ventral surface of the abdomen of a late macrocephalic pupa, showing completed second intersegmental groove and ring-like eighth abdominal segment. × 50.

Fig. 21. External aspect of the posterio-ventral surface of the abdomen of an early teleomorphic pupa, showing partly developed seventh abdominal segment. × 50.

Fig. 22. External aspect of the posterio-ventral surface of the abdomen of an early teleomorphic pupa, more advanced than fig. 21. × 50.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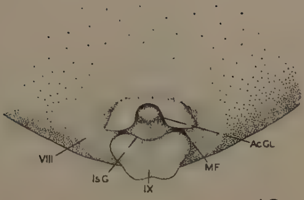
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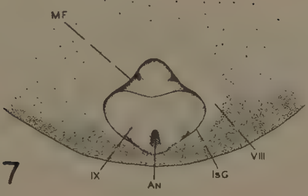
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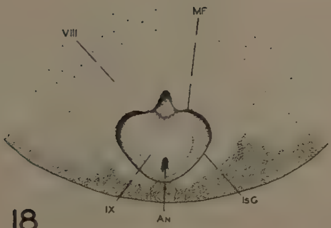
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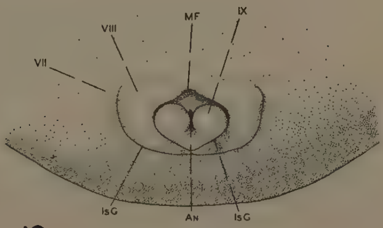
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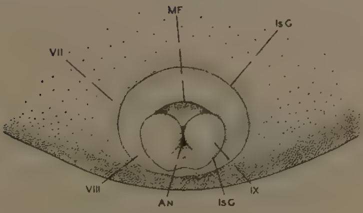
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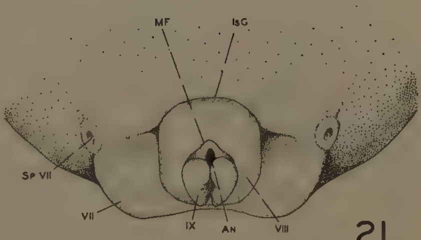
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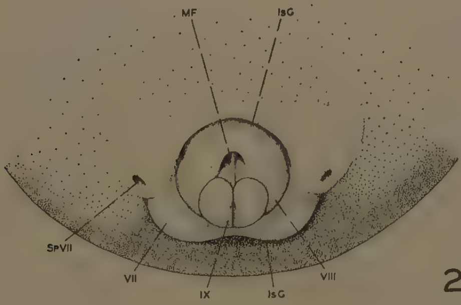
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rudiments remaining at its head and, themselves, enlarging (fig. 25). The lateral oviduct rudiments form a Y-shaped structure with the developing median duct. A third spermathecal rudiment appears between, and slightly before, the original pair. These, and the accessory gland rudiments, now exhibit a definite thin outer cellular layer derived from the cell mass (*Mes*) which previously capped them.

Early teleomorphic pupa. The seventh abdominal segment begins to form anterior to the eighth segment, and in much the same manner, the intersegmental groove starting on the dorsal surface and lengthening ventrally (figs. 21 and 22). Spiracular pits appear on this segment. The eighth segment becomes cylindrical as the intersegmental groove between it and the seventh segment deepens. The lateral lobes of the ninth segment cover the median lobe completely and become closely appressed behind it. The anal and sex-duct openings, at first comparatively distant, are now closer together (fig. 26). The median and lateral duct rudiments and the rudiments of the spermathecae and accessory glands are considerably longer.

Middle teleomorphic pupa. The seventh abdominal segment is completely delimited, with the phragma appearing as a transverse invagination near its anterio-ventral edge (fig. 23, *Phr*). Segment VIII lengthens anteriorly and the intersegmental groove between it and Segment IX becomes less distinct. The lateral lobes of the latter begin to fuse together and elongate, forming a single, tapering projection posterior to the anus, which is no longer visible externally. Within the body, the median and lateral ducts lengthen (fig. 27). A small depression in the floor of the median duct marks the beginning of the ventral receptacle (*V Rcp*). The ends of the spermathecal and accessory gland rudiments become slightly enlarged as division into gland body and duct starts. The outer cellular layer (*Mes*) which covers them extends over the lateral oviduct rudiments, and the beginning of a similar layer on the median duct is indicated by the appearance there of scattered peripheral cells. The lateral oviducts and the median oviduct proper, i. e., that part of the median duct anterior to the ventral receptacle, exhibit a slightly different cytological structure than the remainder of the median duct, the cytoplasm being clearer. In all organs, the intima is more sharply defined, while the epidermal cells of the ovipositor sheath show active secretion of cuticle.

EXPLANATION OF PLATE III

Fig. 23. External aspect of the posterio-ventral abdominal surface of a teleomorphic pupa, showing completed seventh abdominal segment. × 50.

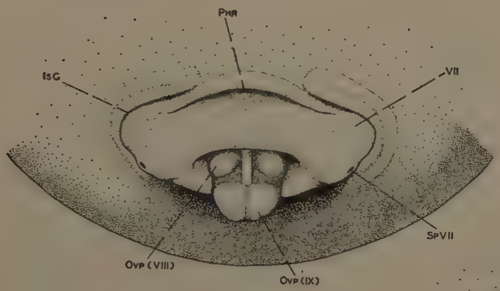
Fig. 24. External aspect of the posterio-ventral abdominal surface of a teleomorphic pupa, essentially imaginal in form. × 50.

Fig. 25. Abdomen of a macrocephalic pupa cut through the median plane, approximately the same stage of development as fig. 18. × 50.

Fig. 26. Abdomen of an early teleomorphic pupa cut through the median plane. Stage of development intermediate between that of figs. 20 and 21. × 50.

Fig. 27. Abdomen of the same middle teleomorphic pupa as fig. 23 cut through the median plane. × 50.

Fig. 28. Abdomen of a late teleomorphic pupa cut through the median plane. Stage of development approximately the same as fig. 24. × 50.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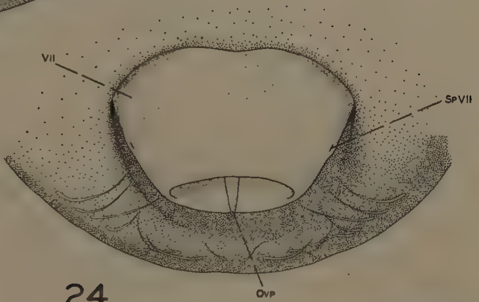
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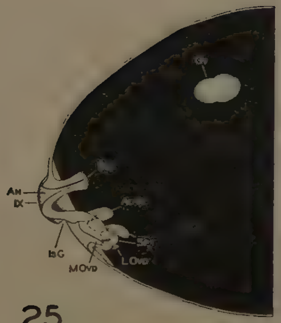
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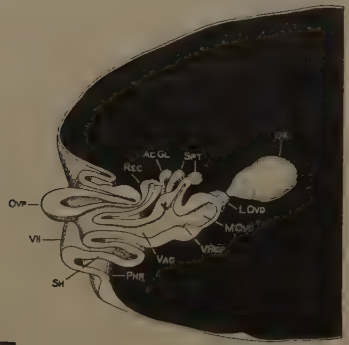
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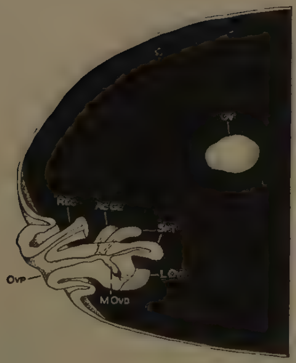
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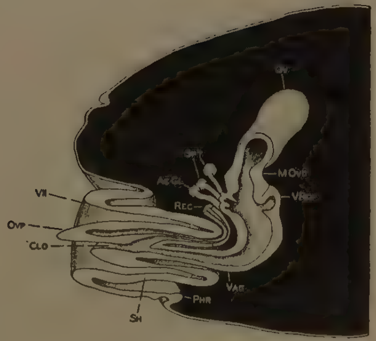
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28

The lengthening lateral oviducts form an initial connection with the gonads. At first this is ligamentous, but later a definite union is established, although the ends of the ducts remain closed. The anal opening and that of the median duct, which have approached each other gradually, now open into a shallow cloaca. Muscles of the body wall begin to form in segment VII.

Late teleomorphic pupa. The adult form of the structures is now distinct. The seventh segment has assumed a truncated-cone shape and only the tip of the ovipositor is visible externally (fig. 24). Its two component lobes are completely fused and are extended to form a slender, tapering point. Only the cloacal opening and the free ends of the ventral processes of the ovipositor remain to mark the junction of the eighth and ninth segments. Within the abdomen, the ovipositor has elongated anteriorly, with a consequent elongation of the cloaca, rectum and sex-duct. The ventral receptacle now forms a distinct invagination in the floor of the median duct, with the ducts of the spermathecae and accessory glands opening directly above it (fig. 28).

Near the end of this phase, the adult histological features appear. The change is very rapid and no intermediate stages were found. The sexual duct is divided into the lateral and median oviducts, bursa copulatrix and vagina. The thin outer cell layer gives rise to the muscle layers of the adult organs, the epithelial layer is reduced and, in most parts, the chitinous intima becomes thicker.

Chromoptic and chromogenic pupae. The only changes occurring before emergence of the adult are the establishment of connections between the ovarioles and the lumina of the lateral oviducts, and pigmentation of some of the organs. The former occurs in the chromoptic phase and, at the same time, the ovipositor assumes its typical amber color. Pigmentation of the body wall occurs in the chromogenic phase. By the time that phase is reached, the female reproductive system is, essentially, adult.

DEVELOPMENT OF THE GONAD

The gonad rudiments are a pair of small, ovoid bodies found in the tenth or eleventh body segments of the larva, where they lie, one on either side, imbedded in the lateral lobes of the dorsal fat body. They are not attached to the body wall, as is the case in many insects.

Explanation of Plate IV

Fig. 29. Longitudinal section through a gonad rudiment in a first instar larva. × 500.

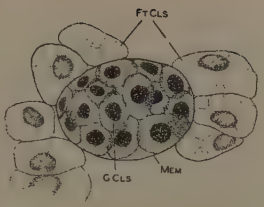
Fig. 30. Longitudinal section through a gonad rudiment in a fourth instar larva, showing a definite peripheral cell layer. × 500.

Fig. 31. Section through a gonad in a cryptocephalic pupa, showing the peripheral layer surrounding the central cell mass except where ovarioles are forming. × 500.

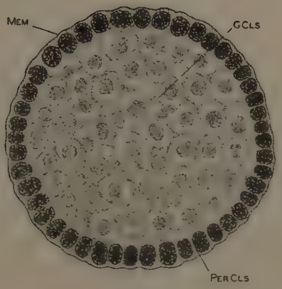
Fig. 32. Longitudinal section through a single ovariole in a teleomorphic pupa. × 500.

Fig. 33. Half of a cross-section through an ovary from an early teleomorphic pupa. × 500.

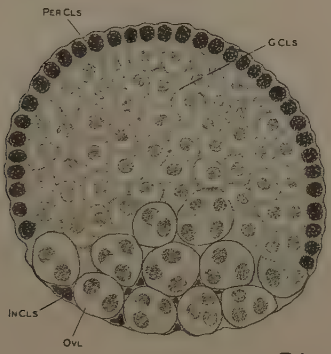
Fig. 34. Part of a cross-section through an ovary from a chromoptic pupa. × 500.


Ft Cls
G Cls
Mem

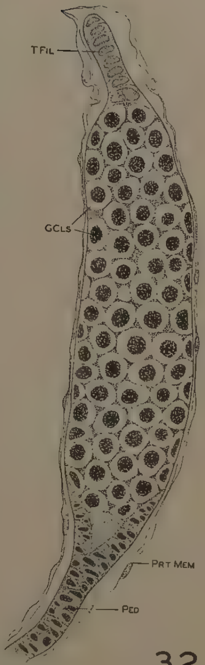
29


Mem
G Cls
Per Cls

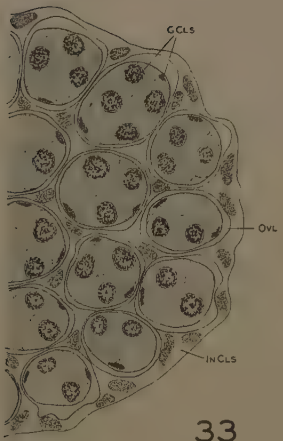
30


Per Cls
G Cls
In Cls
Ovl

31

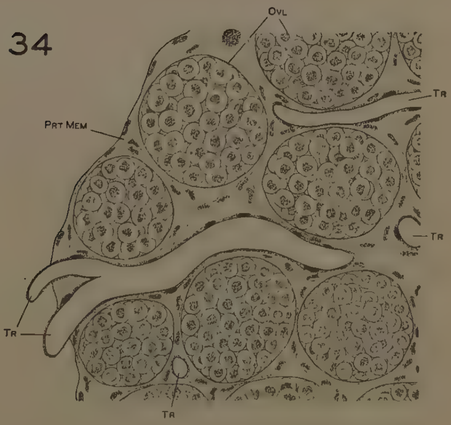

T Fil
G Cls
Prt Mem
Ped

32


G Cls
Ovl
In Cls

33

34


Ovl
Tr
Prt Mem
Tr
Tr
Tr

In the first instar larva, each rudiment consists of a mass of macronucleate cells (*G Cls*) surrounded by a thin membrane and is about 40 microns long by 25 microns wide (fig. 29). In the second larval instar they enlarge somewhat, being 45–50 microns long and 30–35 microns wide. Their structure is the same as in the first instar. In the third instar, the gonads may be found in either the ninth or tenth body segments, still imbedded in the fat body. The undifferentiated cell mass is beginning to separate into a peripheral layer of smaller cells and a central group of larger cells, and is still enclosed in a thin, membranous sac. The approximate dimensions are 85–90 microns in length by 40–50 microns in width.

The gonads in the fourth larval instar and early cryptocephalic phase are similar (fig. 30). They remain imbedded in the fat body but have become almost spherical, with distinct peripheral layers of cells with dark-staining nuclei (*Per Cls*). An external membranous covering is present as before. Size, 60–75 microns in diameter.

In the later cryptocephalic and microcephalic phases, transverse sections of the gonad appear round and measure approximately 80 microns in diameter (fig. 31). Actually, the gonad has begun to assume a bilobed shape, due to the development of the ovarioles. These structures make their first appearance at this time, forming by a sort of budding out from the inner end, i. e., the distal end, of the rudiment. As they enlarge, the gonad becomes bilobed, the developing ovarioles composing one lobe and the original cell mass forming the other. In transverse section, the ovarioles appear as thin, circular tubes containing a loose aggregation of macronucleate cells. Terminal filaments are present in the form of short columns of flattened, discoid cells.

The gonads do not develop at the same rate in all individuals, for in some pupae in an early macrocephalic phase there is yet no indication of ovariole formation and the peripheral layer is still distinct. As the ovarioles form, the peripheral layer disappears and its cells distribute themselves in the interstices between the ovarioles (*In Cls*). The gonad, which now measures 110–120 microns in length by 75–80 microns in width, is still covered by a structureless membrane.

As the ovarioles lengthen, the lobe composed of undifferentiated cells diminishes in size while the body of the gonad increases until, in the overwintered pupa, the rudiment measures 130 microns in length and 90 microns in width. In the late macrocephalic and early teleomorphic phases, the gonad is similar, but with more complete ovariole formation (fig. 33). The interspaces between the ovarioles are filled with small, elongated interstitial cells (*In Cls*) derived from the peripheral layer, while a single thin membrane surrounds the entire gonad.

In the teleomorphic phase, the ovarioles attain a form similar to that seen in the newly emerged adult (fig. 32). The cell mass contained in the ovariole tube now completely fills it, forming a solid cellular column 25 microns in diameter. The ovariole is divided into a distal terminal filament (*T Fil*), body, and basal stalk or pedicel (*Ped*). Definite cellular sheaths derived from the interstitial cells invest each ovariole (*Prt Mem*) and a similar cellular membrane covers the entire ovary. This last persists for a short time in the adult but disappears when the

TABLE I

Life Stage		Gonoduct Development		Gonad Development
		External	Internal	
First Instar Larva		None	Specialized hypodermal cells at site of future histoblasts.	Pair of ovoid cell-masses in posterior dorsal fat body.
Second Instar Larvae		None	Double median histoblast and two lateral rudiments formed.	Gonad slightly enlarged.
Third Instar Larva		None	Histoblasts enlarged, imaginal discs prominent.	Gonad enlarged, peripheral cell layer forming.
FORMATION OF PUPARIUM				
Fourth Instar Larva		None	Similar to above. Enlargement of histoblasts marked.	Gonad almost spherical, peripheral layer distinct.
PUPATION				
Crypto- and Microcephalic Pupae		Genital plate formed before anus.	Evagination and fusion of imaginal discs. Three pairs of invaginations formed.	Ovariole formation begins at anterior end of gonad.
Macrocephalic Pupa	Early	First intersegmental groove starts on ventral side. Two converging marginal folds formed.	Invaginations (=rudiments of lateral oviducts, spermathecae and accessory glands) enlarge.	Gonad enlarged, peripheral layer disappearing.
	Middle	Genital plate and anal histoblast unite. Intersegmental groove elongates.	Rudiment area invaginates, forming rudimentary median oviduct.	Gonad bilobed, larger lobe divided into ovarioles.
	Late	Segment IX delimited, second intersegmental groove starts on dorsal surface.	Median duct elongates, all rudiments larger. Third spermatheca appears.	Ovariole formation more complete.
Telemorphic Pupa	Early	Seg. VII begins to form. Seg. VIII complete. Seg. IX prolonged beyond anus.	All parts elongated. Gonopore and anus open externally in close proximity.	Three sections of ovariole differentiated, sheathed in cell-layer. Gonad larger.
	Middle	Seg. VII completed. Anus not visible externally. Seg. VIII and IX fusing to form ovipositor.	Ventral receptacle begins to form. Anus and gonopore open internally into a short cloaca.	First ligamentous connections between ovary and lateral oviduct.
	Late	Seg. IX elongated and pointed, fusion with Seg. VIII complete.	Ovipositor elongated, essentially adult in structure. Ventral receptacle enlarged.	Ovary and lateral oviduct united externally, no internal connection with lumen.
	Very Late	Essentially adult in form but unpigmented.	Histological differentiation of all structures.	Similar to above.
Chromoptic Pupa		Pigmentation of ovipositor.	Essentially adult in structure.	Ovaries open into lateral oviducts.
Chromogenic Pupa		Pigmentation of all parts.		

EMERGENCE OF ADULT

ovarioles attain their full size. Strands of tissue grow out from these coverings toward the lateral oviduct rudiments, forming the first connections between the primary and secondary sex organs. The gonad proper then unites with the oviduct rudiment, the point of union being at the much reduced remnant of the original gonad cell mass. A connection between the ovary and the lumen of the oviduct is not formed until the chromoptic phase is reached.

TECHNIC

Material for sectioning was preserved in Kahle's fixative, dehydrated and cleared either in alcohol and xylol or alcohol and dioxane, and imbedded in paraffin. Serial sections, usually 10 microns thick, were cut through the entire larva or pupa. Delafield's hematoxylin was used for a nuclear stain and fast green FCF for a counterstain.

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STUDIES OF NORTH AMERICAN PLECOPTERA, with Special Reference to the Fauna of Illinois, by T. H. FRISON, published as Article 2, Vol. 22, Bull. ILLINOIS NATURAL HISTORY SURVEY, pages 231–355, figs. 1–126. 1942.

This volume is the eighth paper of considerable size published by Doctor Frison on the stone flies of the United States. It supplements his various other papers on the group but particularly cleans up the new species and obscure taxonomy of forms which are not mentioned or have only a limited treatment in "The Stoneflies or Plecoptera of Illinois."

The first eight pages are occupied by a discussion of the general problems in the taxonomy of this group. Frison divides the American forms into nine families. A revised list of Illinois species is given which now numbers forty-nine. The work in Illinois, which covers about fifteen years, has been thoroughgoing in the matter of rearing, of checking material carefully against existing types and in the matter of the hundreds of very carefully drawn illustrations. The present volume contains 436 individual figures. It is the type of taxonomy where funds and ability meet and the job is well done.—C. H. K.

THE EXTERNAL ANATOMY OF SANDALUS NIGER KNOCH
(COLEOPTERA, RHIPICERIDAE)[1]

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Department of Zoology and Entomology,
Ohio State University,
Columbus, Ohio

The present study is a contribution to the knowledge of the external anatomy of coleopterous families. Although there have been many extensive phylogenetic studies of the Coleoptera such as Stickney (1923) on the head capsule, Williams (1938) on the mouthparts, Forbes (1922) and Graham (1922) on the wing venation, Sharp and Muir (1912) on the male genitalia, Tanner (1927) on the female genitalia and Boving and Craighead (1930) on larval characters in which parts of the various species of Rhipiceridae were described or figured there is no detailed description of a member of this family. It is intended that this study should parallel the work done by Blackburn (1936) on the Silphidae, Trimble (1935) on the Hydrophilidae, Hayes (1922) on the Scarabeidae, Rivnay (1928) on the Chrysomelidae, and Sweetman (1930) on the Coccinellidae.

PHYLOGENETIC CONSIDERATIONS

Horn (1881) was inclined to believe that the Rhipiceridae were related to the Dascyllidae and Forbes (1922) also placed the Rhipicerids in the Dascylloid group instead of the Elateroid group. Tanner (1927) from a study of the female genitalia and Williams (1938) from a study of the mouthparts both considered the Rhipiceridae related to the Elateridae and Buprestidae but in the Cantheroid series. Sharp and Muir (1912) also show a relationship of this family to the Elateridae and Buprestidae but place these three groups in the Byrrhoidea. Leng (1920) in his list of North American Coleoptera placed the Rhipiceridae in the Elateroidea and Stickney's (1923) phylogenetic studies of coleopterous head capsules indicated the same association.

From the present study it is evident that the Rhipiceridae are very primitive in some characters and highly specialized or abberrant in others. Although specific characters such as genitalia are a useful tool to the taxonomist in separating species, the writer believes that the combined characteristics of the species should be considered in the broader problems of the relationships of genera and families.

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[1] This study was made under the supervision and direction of Dr. C. H. Kennedy, to whom the writer wishes to tender his sincere appreciation for the many helpful suggestions.

SOURCE OF MATERIAL AND METHODS EMPLOYED

On October 5, 1939, a number of beetles of this species attracted the writer's attention by their appearance on several elms (*Ulmus americanus*) and upon shingle oak (*Quercus imbricarius*) in a suburb of northwest Columbus. Most of the females had settled upon the trunks of the trees from a height of two or three inches up to about nine feet, and were ovipositing beneath the bark scales. By means of their elongated ovipositor females were placing their eggs in cracks and crevices of the bark. This phenomenon was very interesting in that the ovipositor was nearly as long as the body of the female so that many eggs could be laid in various regions behind the female without the insect itself moving. One or two males were observed copulating but generally they were on the wing in the vicinity of trees or upon the trunks. All of these specimens were collected alive and the next day several more were obtained. The total collection consisted of about thirty females and six males. Dodge (1941) has mentioned this collection in his observations of *Sandalus*.

The insects were killed in a cyanide bottle and placed in a solution of 70 per cent ethyl alcohol. Dissections were made under a binocular microscope and the drawings made by the aid of the camera lucida. In some cases it was necessary to heat heavily pigmented and sclerotized portions of the insect in a ten per cent solution of potassium hydroxide. Where very delicate parts of the anatomy were concerned they were left in the potassium hydroxide solution for a week or more, no heat being applied.

GENERAL DESCRIPTION

Sandalus niger Knoch is an elongate, convex beetle, the female being more robust than the male. Males range from 17 to 18 millimeters in length and vary in color from black to light brown (fig. 1). In the light brown forms the antennae are orange and the thorax is darker than the elytra. Females range in length from 22 to 25 millimeters in length and are generally black or dark brown (fig. 2). The elytra are punctured and have a faint costa; they taper from base to apex in the male and have their greatest width at the anterior end. In the female the elytra reach their greatest width at the posterior third of their length.

THE HEAD

The head capsule is roughly spherical with prominent antennal tubercles (fig. 4). The frontal suture is much reduced and is visible only in specimens treated with potassium hydroxide. The epicranial arms are well defined by the anterior border of the antennal tubercles. Fig. 3 displays a ventral view of the head showing the occipital foramen (Occ. For.) and the relation between the cervical sclerites (Cv. Scl.) and the head. The mouth-parts are directed ventrally and the head is partly withdrawn into the thorax. The compound eyes are large and visible both dorsally and ventrally.

The *antennae* are serrate in the female and flabellate in the male (figs. 8, 9). Eleven segments are present in both sexes, but in the antennae of the female the two distal segments are fused dorsally. The antennae are inserted into the prominent antennal tubercles directly above the base of the mandibles. The scape or first segment of the antennae is longest, while the pedicel or second segment is the shortest. In the female, segments three to nine have tooth-like projections anteriorly, while segments ten and eleven are more flattened. The segments distad of the second segment are termed the flagellum.

The *gula* forms the ventral exoskeleton of the head posteriorly (fig. 5, Gu.). It is bounded on either side by the gular suture (fig. 3, G. S.). The posterior margin of the gula defines the ventral aspect of the occipital foramen (Occ. For.). The mentum is separated by the dividing suture from the gula.

The *labium* is situated below and behind the maxillae (fig. 3, Lab.), and is attached to the head by the mentum and submentum. The mentum (fig. 3, 5) is roundly triangular and plate-like. It is attached proximally to the submentum which is much reduced. Williams (1938) terms the submentum the area between the mentum and the gula but no particular definition of parts is visible ventrally. The mentum and submentum are not considered by Crampton (1928) as parts of the labium proper. The eulabium or labium proper consists of the ligula, the palpiger and the palpus. The palpiger (fig. 5, Plg.) is attached proximally to the distal margin of the mentum and sparsely covered with fine setae. The ligula (fig. 5, Li.) is elongate, conical and covered with fine hairs. It lies anterior to the palpiger to which it is attached. The labial palpi are three-jointed, the first joint being very small; all are covered with hairs except the tip of the distal segment.

The maxillae are well developed and located between the mandibles and the mentum (figs. 3, 10, 11, Mx.). The basal piece or cardo (Cd) is small and sclerotized. The stipes (St) can be seen dorsally and is attached to the cardo at its proximal end. It is closely applied to the lacinia. The lacinia, (Lac) is a large and triangular plate covering the stipes and part of the palpifer ventrally. The galea, (Gal.) is cylindrical, hairy and joined to the interior, distal part of the lacinia. The palpifer, (fig. 10, Plf) is proximally joined to the stipes and bears the maxillary palpus at its anterior end. The maxillary palpi (fig. 11, Mx. Pp.) are four-jointed, the first segment being very small; the remaining segments are large, cylindrical and densely clothed with hair. The tip of the distal segment is hairless and unpigmented; this is generally the area bearing sensory organs in insects.

The *mandibles* are large and heavily sclerotized (figs. 6, 7). A dorsal and ventral condyle, (D. c., V. C.) are present at the basal region of the mandibles. These articulate in cavities of the head capsule. MacGillivray (1923) gives the terms of preartis or dorsal condyle and postartis or ventral condyle. The distal and median portion of the inner edge of the mandible are provided with flat, tooth-like projections. The median tooth is very thin. The dorsal surface of the mandibles is fairly smooth but the ventral surface has a deep concave depression at the innermost median half.

The labrum is a small, bilobed structure (fig. 4, Lbr.) and is apparently fused to the head capsule since no suture separating the two can be found.

The *endoskeleton* of the head is much reduced as compared to the endoskeletal structures in other beetles, Stickney (1923). The tentorium consists of the anterior arms which have their external tentorial pits situated just anterior to the antennae and a pair of slender posterior arms which are parallel and dorsal to the gular suture (fig. 12, Ant. Arm., Post. Arm.).

THE CERVICAL SCLERITES

The paired sclerites of the cervix or neck are situated in the ventral membranous area connecting the head with the thorax, (figs. 13, 14). These articulate between the head and the sternum. Stickney (1923) terms the cephalic sclerite the *cervepisternum* and the thoracic sclerite the *cervepimeron*. The cervepisternum is elongate and has tuberosities at each end. The cervepimeron is much smaller than the former and is elongate oval in form.

THE THORAX

The *pronotum* is conical, rounded and is finely punctured and hirsute; it is about as broad as long. The pronotum has a faint, median, longitudinal suture which is deepest anteriorly. A transverse, upturned ridge

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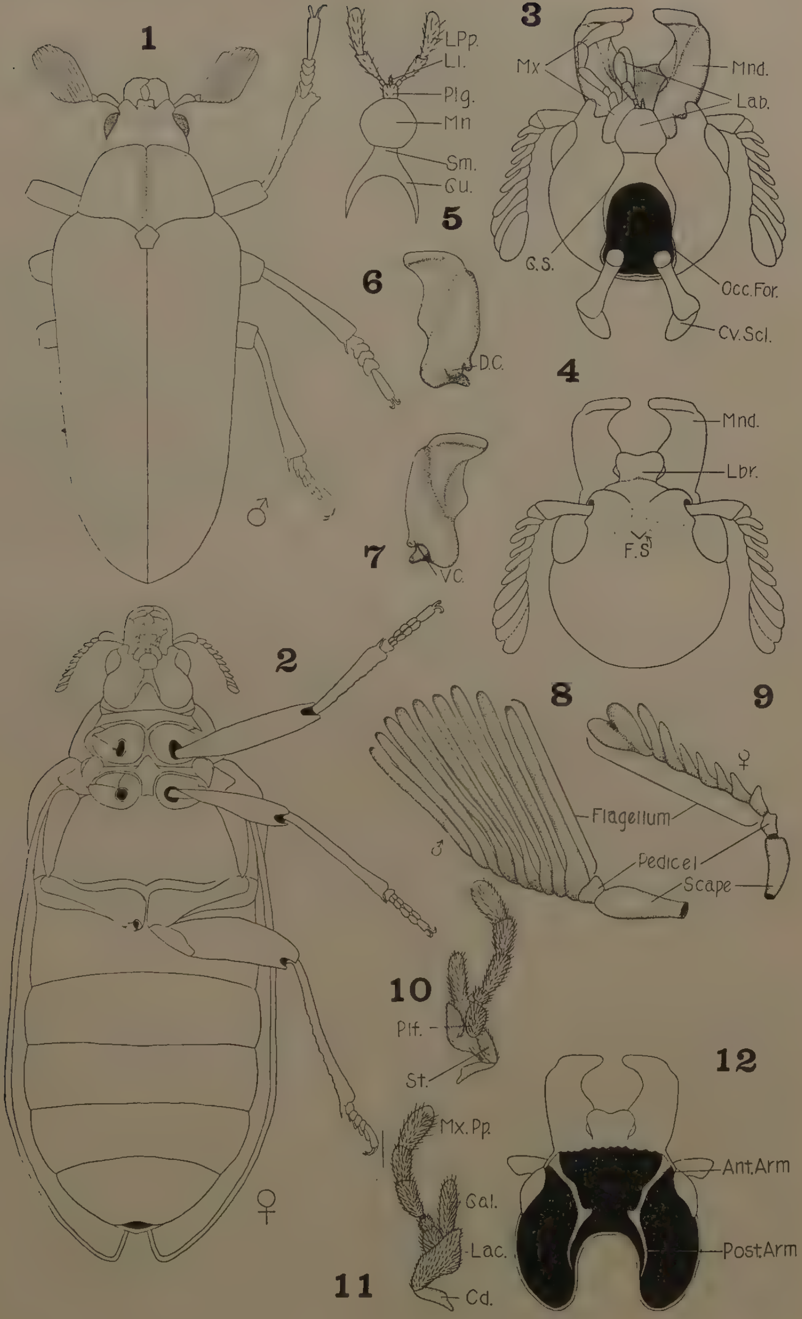
EXPLANATION OF PLATE I

Sandalus niger

Figs. 1 and 8, male. Figs. 2–7, and 9–12, female. 1. Male. 2. Female. 3. Head and cervical sclerites. 4. Head, dorsal aspect. 5. Labium. 6. Mandible, right, dorsal surface. 7. Mandible, right, ventral surface. 8. Antenna, male. 9. Antenna, female. 10. Maxilla, left, ventral aspect. 11. Maxilla, left, dorsal aspect. 12. Tentorium, dorsal aspect.

Ant. Arm.—anterior arm of tentorium. Cd.—cardo of maxilla. Cv. Scl.—cervical sclerite. D. C.—dorsal condyle of mandible. F. S.—frontal suture. Gal.—galea of maxilla. G. S.—gular suture. Gu.—gula. Lab.—labium. Lac.—lacinia. Lbr.—labrum. Li.—ligula. L. Pp.—labial palpus. Mn.—mentum. Mnd.—mandible. Mx.—maxilla. Mx. Pp.—maxillary palpus. Occ. For.—occipital foramen. Plf.—palpifer. Plg.—palpiger. Post. Arm.—posterior arm of tentorium. Sm.—submentum. St.—stipes. V. C.—ventral condyle of mandible.


1
♂
2
♀
3
Mx
Mnd.
Lab.
G.S.
Occ.For.
Cv.Scl.
4
Mnd.
Lbr.
F.S
5
LPp.
Li.
Plg.
Mn
Sm.
Gu.
6
D.C.
7
VC.
8
♂
Flagellum
Pedicel
Scape
9
♀
10
Plf.
St.
11
Mx.Pp.
Gal.
Lac.
Cd.
12
Ant.Arm
Post.Arm

on the anterior margin of the pronotum makes it possible for the head to be partly withdrawn into the thorax.

The *prosternum* is small and about four times as broad as long; the posterior median area of the prosternum bears a forked projection into which the anterior median projecting piece of the mesosternum articulates. Internally there are two pairs of furcae; the anterior pair is small and pointed while the posterior pair is larger and each branch is enlarged at its apex. These furcae are for the attachment of muscles (figs. 13, 14).

The *mesotergum* is small with only the scutellum heavily pigmented, (fig. 16). The scutellum (Sctl) is the only portion of the mesotergum visible when the elytra are folded in a natural position. The scutum, (Sct) (fig. 19) which makes up the greater part of the mesotergum is projected beneath the pronotum and is connected to the phragmata of the metathoracic praescutum, (fig. 16). The elytra articulate with the mesotergum by a membranous area containing the axillary sclerites (AxScl). There is also a median lateral projection termed the elytral articulation (fig. 16, Ely Art). The posterior lateral sides of the mesotergum are elongated to form the posterior notal wing process (fig. 19, PNWP), (Snodgrass, 1935). Internally there is a V-shaped ridge at the anterior portion and a faint V-shaped ridge at the connection of the scutum and the scutellum.

The *mesopleuron* is composed of two, principle plates (fig. 15). The episternum is elongate and bears upon the dorsal surface the wing processes of the elytra. An episternal suture separates the supraepisternum (S-Eps) from the infraepisternum (I-Eps). The episternum is attached posteriorly to the epimeron and at the dorsal portion of this junction there is a small groove in which the outer edges of the elytra fit when they are folded over the body. The epimeron is quadrangular and is rounded at all angles except where it joins the episternum. This junction is known as the pleural suture.

The *mesosternum* is twice as broad as long and is closely attached to the episternum. It is wider posteriorly than anteriorly and has a forward projecting piece on the median plane which articulates with the

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EXPLANATION OF PLATE II

Sandalus niger

13. Prosternum, dorsal internal view. 14. Prosternum, ventral external view. 15. Side view of thorax. 16. Mesotergum and metatergum, external dorsal view. 17. Metatergum, ventral internal view. 18. Mesosternum and metasternum, ventral external aspect. 19. Mesotergum, ventral internal view. 20. Mesosternum and metasternum, dorsal internal view.

Roman numerals refer to respective structures of the thorax. I.—prothoracic structures. II.—mesothoracic structures. III.—metathoracic structures. A. Ph.—anterior phragmata. Ax. Scl.—axillary sclerite. Cv. S.—convergent suture. Cv. Scl.—cervical sclerite. Cx.—coxa. Ely.—elytra. Ely. Art.—elytral articulation. Epm.—epimeron. Eps.—episternum. Fur.—furca. H. W.—hind wing. I.—Eps.—infraepisternum. M. D.—muscle disc. P. N. W. P.—postnotal wing process. Post. Sctl.—postscutellum. Praes.—praescutum. Prn.—pronotum. Sct.—scutum. Sctl.—scutellum. Sct-Sctl-S.—scutoscutellular suture. S-Eps.—supraepisternum. Sp.—spiracle. Spn.—spinasternum. St. I.—prosternum. St. II.—mesosternum. St. III.—metasternum. Ter.—tergite. Tr.—trochantin. Tr-I-S.—transverse intrascutal suture.

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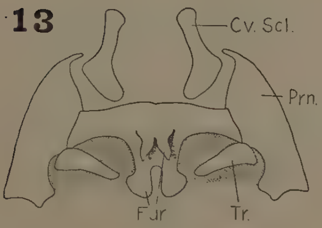
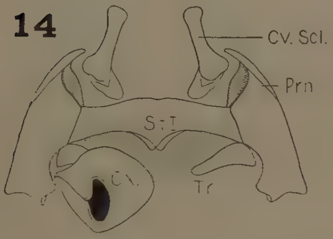

Cv. Scl.
Prn.
Fur
Tr.

14


Cv. Scl.
Prn
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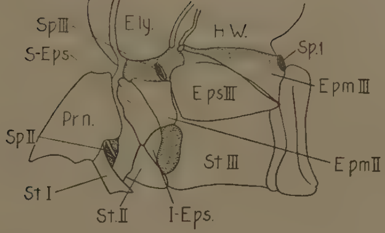
15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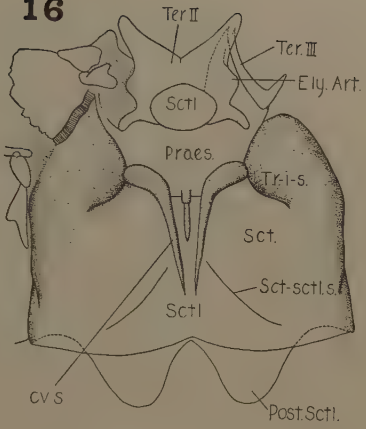
I-Eps.

16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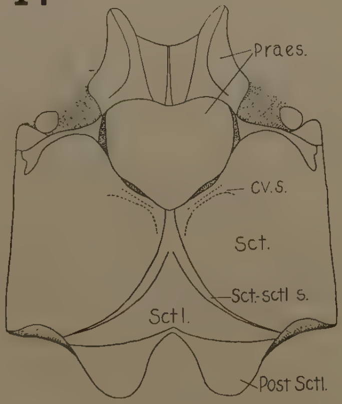
17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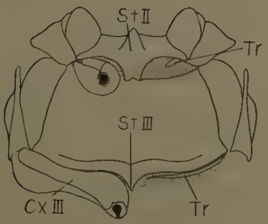
Sctl.
Post Sctl.

18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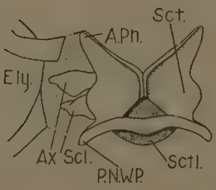
Tr


Sct.
A.Ph.
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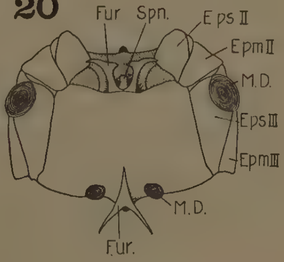
Ax Scl.
P.N.W.P.
Sctl.

19

20


Fur
Spn.
EpsII
EpmII
M.D.
EpsIII
EpmIII
M.D.
Fur.

complimentary bilobed piece of the posterior prosternum. The mesosternum also has a bilobed posterior projecting piece which probably represents the spinasternum. Snodgrass (1935) states that the spinasterna are intersternites of the thorax and that in some cases they are fused to the preceding sternite proper or eusternum. Each spinasternum bears a median apodemal process termed the spina (fig. 20, Spn). The posterior projecting piece of the prosternum no doubt also has such a relation to the prosternum. Internally besides the spina there is a larger bilobed furca (Fur).

The *metatergum* is the largest tergite, extending from beneath the pronotum posteriorly to and beneath the first abdominal segment. There are four principal divisions of the metatergum; first the perascutum which is attached anteriorly to the anterior phragmata of the mesotergum and lies beneath the scutum and scutellum of the mesothorax. Second the scutum, which is the largest sclerite of the tergum (figs. 16, 17). Anteriorly it borders the praescutum. The convergent sutures (Cv.S.) are arranged so as to form a pair of club-shaped areas in the medial tergal area. They arise anterolaterally from the scutum and gradually converge toward the median line of the tergum. A transverse intrascutal suture (Tr.I.S.) arises from the lateral margin of the convergent suture and extends posterolaterally. The scutoscutellular suture (Sct-Sctl-S) is V-shaped with its apex overlapping the apex of the convergent sutures although reversed. Internally the scutoscutellular suture forms a large V-shaped ridge, its apex directed anteriorly. Third the scutellum (Sctl.) is a comparatively small, triangular sclerite bounded anteriorly by the scutoscutellular suture and posteriorly by the suture separating it from the postscutellum. Fourth, the postscutellum, (Post.Sctl.) is the infolded, bilobed area which projects posteriorly beneath the primary abdominal tergites, MacGillivray (1923).

The *metapleuron* is large as compared to the mesopleuron and consists of two, large plates (fig. 15). The episternum (Eps. III) is roughly triangular and the dorsal projecting angle of the sclerite is narrowed into the parapterum. The epimeron (Epm. III) is lightly pigmented and somewhat membranous on the dorsal half but is hard and heavily pigmented otherwise. The forward projecting angle of the epimeron is narrowed and bears a knob-like wing process. Internally there is a large muscle disc (M.D.) attached to the epimeron.

The *metasternum* (figs. 18, 20, St. III) is much larger than the mesosternum with which it is closely united medially. It bears a median projecting knob which articulates with the spinasterna of the mesothorax. The close fit of this articulation serves to cover the membranous area between the mesothoracic coxae. There is a medial sternal suture having its origin at approximately the center of the sternum and extending posteriorly to the median end of the sternum. This suture evidently marks the inflection of the body wall to form the internal furcae. The metathoracic furca is a three-pointed structure, the anterior arm being the origin of the inflection and the two posterior arms extending lateroposteriorly for the attachment of muscles. A pair of muscle discs are situated on each side of the furca. A transverse suture is also present which curves parallel to the posterior margin of the metasternum.

THE THORACIC APPENDAGES

The *elytra* are punctate, heavily pigmented, and covered with a fine pubescence. The costa is faint. The elytra articulate with the lateral processes of the mesotergum, the elytral articulation and the wing process. They are joined to the tergum by a membranous area containing the axillary sclerites (Ax.Scl.).

The *hind wings* are membranous and of the usual coleopterous form. Forbes (1922) regards the Rhipicerid type of venation as being almost identical with the Dascyllid group. This author places these two types in the Dascylloidean type of wing structure, which is characterized mainly by the lack of characters of the other groups, thus resembling the more primitive types of Macrodactylia and Clavicornia. The costa is short with very little membrane anterior to it. The subcosta is approximately two-thirds the length of the wing. The radius is reduced and broken up into darker areas. The stem of the radial sector (RS) is combined with the radial cross-veins (r). The radio-medial crossveins connect the medius (M) with the stem of the radial sector. The medius is clearly defined and is anteriorly bent back to form a hook. The first medial branch is separated from its origin but distinct and the second and third medial branches are wanting. The fourth medial branch is fused with the cubitus to form the medio-cubital branch (M_4+Cu). The cubito-anal crossvein (cu-a) connects the medial with the second anal vein and its branches, ($2A_1$, $2A_2$). The first anal vein is isolated (1A). The third anal vein is forked and is connected to the second anal vein by the characteristic wedge cell (w). A fourth anal vein is also present.

The *thoracic spiracles* are situated in membranous areas of the meso- and metathoracic segments (fig. 15, Sp. II, Sp. III) although they appear to be in the pro- and mesothorax respectively. The first thoracic spiracle is located just posterior to the union of the pronotum and prosternum. The second is located dorsally of the mesothoracic epimeron.

The *legs* are similar in structure. The prothoracic legs are the smallest and the metathoracic legs the largest. The prothoracic and mesothoracic trochantins are small and crescent shaped (figs. 13, 18 Tr.). The hind trochantin is very elongated. The first and second coxae are globular, while the hind coxa is transversely elongated with a distinct ridge. The hind coxae cover the first two abdominal segments. The prothoracic and mesothoracic coxae are separated by the sternites and the spinasterna. The trochanter is small but distinct, (Trc.). The femora (Fem.) are smooth and are supplied with ventral grooves into which the proximal region of the tibia fit when the legs are folded (fig. 2). The tibia, (Tb.) is smooth on its inner surface but roughened and hairy on the outer side. The tibia bears two, short, curved spines at the inner apex, (Tb.Sp.). The tarsi are all five-jointed. The first four segments bear the tarsal pulvilli or hairy pads (fig. 25). The distal tarsal segment is the largest and bears two sharply hooked claws and between these a small arolium. The arolium consists of two parts; the basal unguitractor which is oval and deeply cleft at its distal end; the empodium or distal segment, which is club-shaped and bears short setae at its base, but longer setae on the terminal portion. Hayes and Kearn (1934) have figured both the arolium and the tarsus of *Sandalus niger*.

THE ABDOMEN

The tergites of the abdomen are thin, overlapping and light brown in color (fig. 28). The first segment is membranous, with a V-shaped median line, the apex of which is directed posteriorly. The second segment is also membranous though more pigmented than the first. The lateral margins of the first and second segments extend ventrally and anteriorly and the first includes the first large abdominal spiracle (fig. 15, Sp. 1). The third to seventh tergites are visible dorsally with the wings and elytra removed. These segments are more heavily pigmented than the first two tergites. The eighth segment is partly retracted into the seventh and is eversible. It is comparatively small and pigmented and hairy at its anterior half.

The segments labeled ninth (IX) appear to be clearly defined in both sexes but it can not be certain that this terminology is absolutely correct until a study of the post embryonic development has been made. The ninth and tenth segments envelop the genitalia of the male and form most of the external portion of the female ovipositor.

The sternites are more heavily sclerotized and pigmented than the tergites. They are the same color as the ground color of the beetle. The first abdominal sternite is entirely membranous and is covered by the metathoracic coxae. The second segment is membranous except for the posterior lateral margins where it is sclerotized. The third to seventh abdominal sternites are finely punctate. They overlap and are covered with fine hair. In the female the eighth sternite is normally retracted within the seventh and in the male the tip of the eighth segment is exposed in a natural position. The eighth, ninth and tenth abdominal sternites and their appendages constitute the genitalia of the female.

The *abdominal spiracles* are eight in number. The first spiracle is largest and best developed (fig. 28, Sp.). It is situated in the membranous first tergite of the abdomen close to the thorax. The second-third, fourth, fifth and sixth spiracles are well defined in small semi-sclerotized areas at the anterolateral angle of each abdominal tergite.

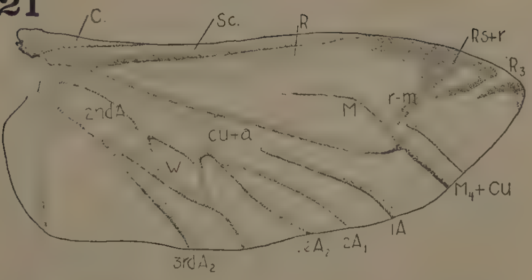
EXPLANATION OF PLATE III

Sandalus niger

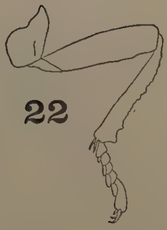
Arabic numerals refer to the first seven segments of the abdomen. Roman numerals VIII, IX, X refer to the terminal abdominal segments. 21. Hind wing. 22. Mesothoracic leg. 23. Metathoracic leg. 24. Prothoracic leg. 25. Tarsus. 26. Female abdomen, side view showing ovipositor retracted. 27. Female abdomen, lateral view showing ovipositor extended. 28. Female abdomen, dorsal view. 29. Tip of male abdomen, ventral view; seventh sternite removed. 30. Ninth and tenth male abdominal segments, dorsal view. 31. Ninth and tenth male abdominal segments, lateral view. 32. Phallic organs, lateral aspect. 33. Phallic organs, dorsal aspect. 34. Phallic organs, ventral aspect. 35. Tip of ovipositor, ventral view. 36. Ovipositor, ventral external aspect.

A.—anal vein. Ad.—aedeagus. B. P.—basal piece. C.—costal vein. Cox.—coxite. Cu.—cubital vein. cu.—cubital crossvein. Cx.—coxa. Fem.—femur. M.—medial vein. m.—medial crossvein. Ovd.—oviduct. Ovr.—ovariole. R.—radial vein. r.—radial crossvein. Rs.—radial sector. Sc.—subcostal vein. Sp.—spiracle. Sty.—stylus. Tar.—tarsus. Tb.—tibia. Tb. Sp.—tibial spur. Trc.—trochanter. Val.—valvifer. w.—wedge cell.

21


C.
Sc.
R
Rs+r
R$_3$
r-m
M
2nd A
cu+a
W
M$_4$+Cu
IA
2A$_1$
2A$_2$
3rd A$_2$

22



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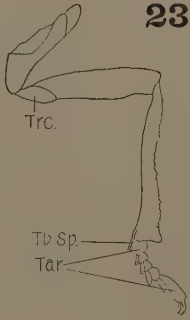
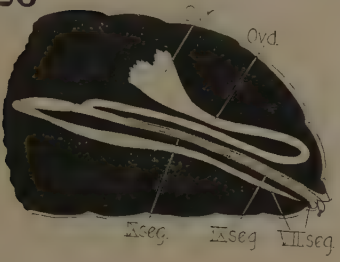
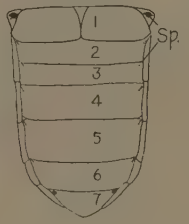

Trc.
Tb Sp.
Tar.

26


Ovr.
Ovd.
X seg.
IX seg
VIII seg.

28



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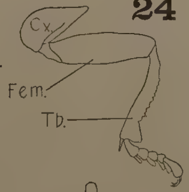

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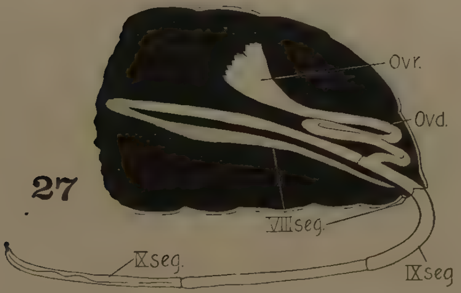
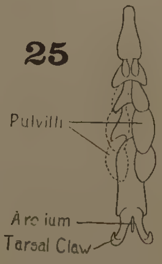
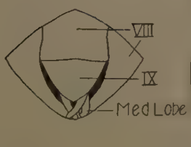

Ovr.
Ovd.
VIII seg.
X seg.
IX seg

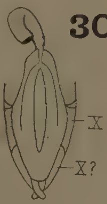
25


Pulvilli
Arolium
Tarsal Claw

29


VIII
IX
Med Lobe

30



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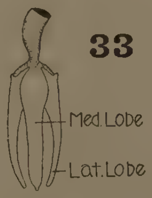
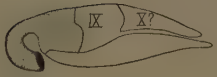
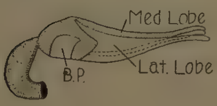

Med. Lobe
Lat. Lobe

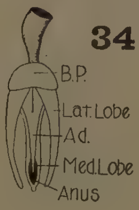
31



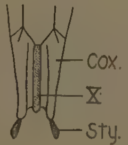
32


Med Lobe
Lat. Lobe
B.P.

34


B.P.
Lat. Lobe
Ad.
Med. Lobe
Anus

35



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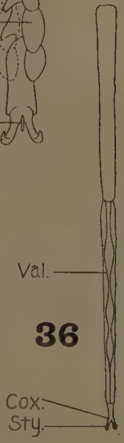

These spiracles are hidden in the folds of the segments where the sternites and tergites converge. The seventh spiracle appears to be situated in the anterolateral margin of the tergite itself. The area which surrounds the spiracle is more heavily pigmented than in preceding segments. The eighth spiracle is situated on the ventral edge of the eighth tergite.

THE MALE GENITALIA

The sclerotized portion of the male genitalia consist of four structures, only one of which, the paired lateral lobes, is double. These sclerites are completely enveloped by the ninth segment (fig. 31, IX). The basal piece (figs. 32, 34, B.P.) forms the proximal portion of the genitalia. Dorsally the median lobe (fig. 33) is elongate, enlarged at its base and narrowed at the terminal end. There is a small knob at the tip of the median lobe. This structure is membranous basally but the remainder is pigmented and sclerotized. The median lobe serves as a protection to the aedeagus which it envelops laterally and dorsally. When viewed ventrally the interior of the median lobe is supplied with membranous tissues which appear to surround the anus (fig. 34).

The lateral lobes are comparatively large, roundly pointed at their apex and widening at the base where they converge ventrally. According to Sharp and Muir (1912) the term "lateral lobes" is synonymous with the parameres or "claspers" of other authors. The long slender piece ventral to the median lobe seems to be a specialized structure which is not present in the Rhipicerid *Callirhipes* of Sharp and Muir. This structure is thought to be the aedeagus which Snodgrass (1935) describes as typically a sclerotic tube. The aedeagus is very narrow and tubular distally but wider at the base. It bears a small gonophore or median orifice at the tip. The membranous tube attached to the proximal end of the median lobe is apparently the internal sac as described by Sharp and Muir (1912) in *Callirhipes*. The duct is greatly enlarged just above the aedeagus.

THE FEMALE GENITALIA

The genitalia of the female *Sandalus niger* are very complex internally and the associations of the various structures are not clear in preserved material. It is fairly evident that the various structures which constitute the ovipositor are segments or appendages of the eighth, ninth and tenth abdominal segments. The long slender sclerotized rod to which the retractor muscles of the ovipositor are attached appears to be an apodeme of the eighth sternite (figs. 26, 27). Tanner (1927) mentions several species of Coleoptera which have one or more apodemal structures extending anterior to the eighth sternite. The ninth segment is membranous though it is lightly pigmented. It is turned completely inside out when the ovipositor is retracted within the body (fig. 26). The two figures 26 and 27 are somewhat diagramatic but the writer has endeavored to show the relation of parts when the ovipositor is extended and when it is contracted. The ninth valvae consist of the valvifers, (Val.), the coxites (Cox.), and the styli (Sty.) (fig. 37).

The sclerotized remnant of the tenth sternite is found between the coxites on their ventral surface.

The coxite is setiferous and bears a small stylus. Tanner (1927) states that the valvifer is present only as a long, slender baculum. The baculum is, according to his terminology, the rod-like structure supporting the valvifers, coxites or styli.

The internal organs of reproduction have not been worked out but it is hoped that the writer may be able to do this in the future since the connections of these organs to the external parts might serve as very important sources of information as to the location of specific features. The path of the eggs was followed and it was found that the eggs pass through the ovariole, oviduct and into a lightly pigmented tube which leads into the ninth tubular segment. This tube may be a part of the ninth segment; the eggs pass out through an opening between the styli. The ovarioles are not closed but seem to be disintegrated in their anterior portions so that the eggs fill the entire abdominal cavity and also in part the thoracic cavity. It is apparent that most of the internal organs and tissues of the abdomen more or less disintegrated during the oviposition period. It is thought that all of the energy and assimilative materials possible are given over to the mass production of eggs. The enormous number of 16,864 eggs were counted in a large female.

SUMMARY

This study of *Sandalus niger* Knoch, Family Rhipiceridae, is a contribution to the knowledge of the external morphology of coleopterous families. It is intended that this work should parallel anatomical studies by others on various families of the Coleoptera. Although there are many extensive phylogenetic studies of the Coleoptera on the head capsule, mouth parts,wing venation, larval characters and both male and female genitalia in which such parts of the various species of Rhipicerids (*Sandalus* and *Callirhipes*) were described or figured there is no detailed description of a member of this family.

The Rhipiceridae are apparently very primitive in some characters but rather highly specialized in others, hence the sum total of these characteristics must be considered in the phylogeny of the family.

The ovipositor of the female seems to be very unusual and when extended nearly equals the body in length. A superficial study of the internal organs of reproduction of the female indicates that most of the tissues of the abdomen transform their accumulated energy over to the mass production of eggs. 16,864 eggs were counted in a single, large female.

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APPLIED ENTOMOLOGY. An Introductory Textbook of Insects in their Relations to Man. By H. T. FERNALD AND HAROLD H. SHEPARD. Pages x + 400. 283 figures; fourth edition, 1942. 6 x 9 inches. Published by MCGRAW-HILL BOOK COMPANY, INC., New York. Price, $3.50.

While nearly a third of this book has been rewritten in order to include new information on insect control, there is no fundamental change from previous editions in the style or scope of the book. Chapters I–IV deal with the place of insects in the animal kingdom, and with the structure and development of insects; Chapters V–IX deal with the economic importance of insects, and with insecticides and other means of insect control; Chapter X deals with classification; Chapters XI–XXXIII deal with the various insect orders; and Chapter XXXIV deals with animals other than insects.

Chapters V–IX have been completely rewritten and brought up to date, and include new insecticides that have come into general use; methods and materials of recent development that have not yet had widespread use are treated but slightly or not at all.

The fact that this book is in its fourth edition indicates its popularity and usefulness in beginning courses in economic entomology. There are two rather important phases of the subject, however, which this book either omits or gives but slight treatment. There is no general discussion of insect ecology—to give the student a background for thinking of control in terms of ecology—and there is only a single page on biological control, a subject which would seem to deserve more consideration in a text of this sort.

This book is one of the "McGraw-Hill Publications in the Agricultural Sciences," and has the excellent binding, paper, and workmanship of these publications.—D. J. BORROR.

THE MOUTHPARTS OF BLACKFLIES WITH SPECIAL REFERENCE TO EUSIMULIUM LASCIVUM TWINN[1]

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The work herein described is a special study of a local species, *Eusimulium lascivum* Twinn. Though this species occurs in considerable numbers at the outlet of Cayuta Lake, N. Y., it has never been taken, to the author's knowledge, in the act of taking blood. Whether it is a bloodsucker is doubtful for, despite its abundance, it did not attack while the author was collecting his specimens.

THE STRUCTURE OF THE HEAD AND MOUTHPARTS OF THE FEMALE

THE HEAD CAPSULE

The head capsule of *Eusimulium lascivum* Twinn (female) is roughly spherical in shape. It is flattened antero-posteriorly and truncate at its junction with the mouthparts which are suspended from the ventral surface.

The cephalic aspect of the head is made up of the fronto-clypeus, the vertex, and the eyes. The convex fronto-clypeus extends up from the mouthparts to meet the vertex, which extends down from the top of the head. Between the two are the antennal sockets.

The lateral areas of the head are almost entirely taken up by the eyes. The genae are only slightly lateral, each being a very narrow sclerite between the eye and the mouthparts. The postgenae and vertex extend somewhat to the lateral surface.

The posterior surface of the head is made up of the occiput, postgenae, the sclerites of the fused cardo and stipes, and a narrow membranous area between them. All of these surround the foramen magnum. The occiput extends down from the vertex to about the level of the occipital condyles. The areas on either side of the foramen magnum are occupied by the postgenae which extend from the lower edges of the occiput to the upper ends of the mouthparts. They also extend below the foramen magnum covering all of this area with the exception of that taken up by the sclerites of the cardo and stipes and the membranous area between them. The occiput, genae, vertex, and postgenae are not separated by sutures in this fly. The limits of these sclerites, as described above, are as defined by Jobling (1928) for *Culicoides pulicaris*.

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[1] Contribution from the Department of Entomology, Cornell University, Ithaca, N. Y.

THE MOUTHPARTS, RELATIVE POSITION

In blackflies the mouthparts are suspended in a continuous membrane from the lower surface of the head capsule. This membrane, in addition to binding the mouthparts to the head capsule, joins them with one another. They articulate either with sclerotized extensions of the head capsule or act freely in the membrane.

The labrum-epipharynx is in front of all the rest of the mouthparts. Behind it are the mandibles. Their proximal ends are lateral to and behind the lateral limits of the labrum-epipharynx. Their distal ends lie one over the other in the midline. Next come the maxillae. Each consists of a palpus, a galea, and a fused cardo and stipes. The sclerite of the cardo and stipes is attached to the posterior wall of the head. The hypopharynx lies in the midline suspended from the posterior wall of the pharyngeal pump, behind the crossed ends of the mandibles, mesad to the galeae, and immediately anterior to the labium. The labium, which is composed of two three-segmented lobes partially fused in the midline, contains the other mouth-parts in its troughlike anterior face.

DETAILED DESCRIPTION OF THE MOUTHPARTS

The labrum-epipharynx. The labrum-epipharynx is essentially a three-sided pyramid with its base attached to the head, (Plate I, D, E; II, C; LBR.-EP.). The two lateral walls attach to the membrane suspended from the fronto-clypeus. The posterior wall is continuous with the anterior wall of the pharyngeal pump, (Plate II, C; LBR.-EP.). The labrum-epipharynx is largely membranous, with sclerotized areas along the corners formed by the three walls and along the midline of the posterior wall, (Plate I, D, E; II, C; LBR.-EP.). The sclerotization along the anterior corner is Y shaped. The arms of the Y form the bases of the lateral walls. They meet extensions from the sclerotizations at the lateral corners, whose other arms continue posteriorly to the lower anterior corners of the pharyngeal pump, (Plate II, C). These two points of contact form the fulcra for the levation and depression of the labrum-epipharynx. The four longitudinal sclerotizations meet at the apex to form a strongly sclerotized point.

Musculature. Two sets of muscles are inserted on the sclerotization of the posterior wall of the labrum-epipharynx. The proximal set takes its origin on the fronto-clypeus just above its junction with the labrum-epipharynx. The distal set arises at the junction of the arms of the Y-shaped anterior sclerotization (Plate II, C; COMP. LBR.-EP.). Inserted on the same region is a group of muscles whose origin is on the midline of the fronto-clypeus between the origins of the dilators of the pharyngeal pump (Plate II, C; LEV. LBR.-EP.).

The first two groups of muscles are evidently compressors of the labrum-epipharynx. Their contraction would increase the size of the food channel formed by the mouthparts and perhaps, in this way, be the first step in the pumping process. The third set of muscles acts as the levator of the labrum-epipharynx which swings on its fulcra as described above.

A fourth muscle, associated with the muscles of the labrum-epipharynx, takes its origin on the vertex. Its insertion is on the fronto-clypeus at its junction with the vertex, (Plate II, C; TENS. FR.-CL.). This muscle is probably a tensor muscle to prevent the fronto-clypeus from bending under the pull of the levator of the labrum-epipharynx.

The Mandibles. Each mandible is a thin, crescentic blade which is suspended from the head capsule with its flat sides facing antero-posteriorly. The blade is slightly concave anteriorly on its distal half. The lateral margin becomes heavier as it approaches the point of articulation. Above this point the mandible is somewhat cylindrical and terminates proximally with its end obliquely truncate (Plate I, figs. A and E; MD.). The latero-posterior aspect of this cylindrical portion is concave so that it forms an angle with the lateral margin of the blade proper. The knob-like projection thus formed serves as the point of articulation between the mandible and the sclerotized, hooklike process of the fronto-clypeus (Plate I, fig. A, MD. COND. and E; MD.). The cylindrical end beyond the point of articulation swings freely in the membrane. This membrane, in which the mandible is suspended, is attached to the upper third of the lateral edge of the mandible.

The mesal edge of the mandible is thin. It is produced into a thin, transparent lamella which increases in area toward the distal end and then decreases rapidly until at the tip of the blade it is gone (Plate I, A;

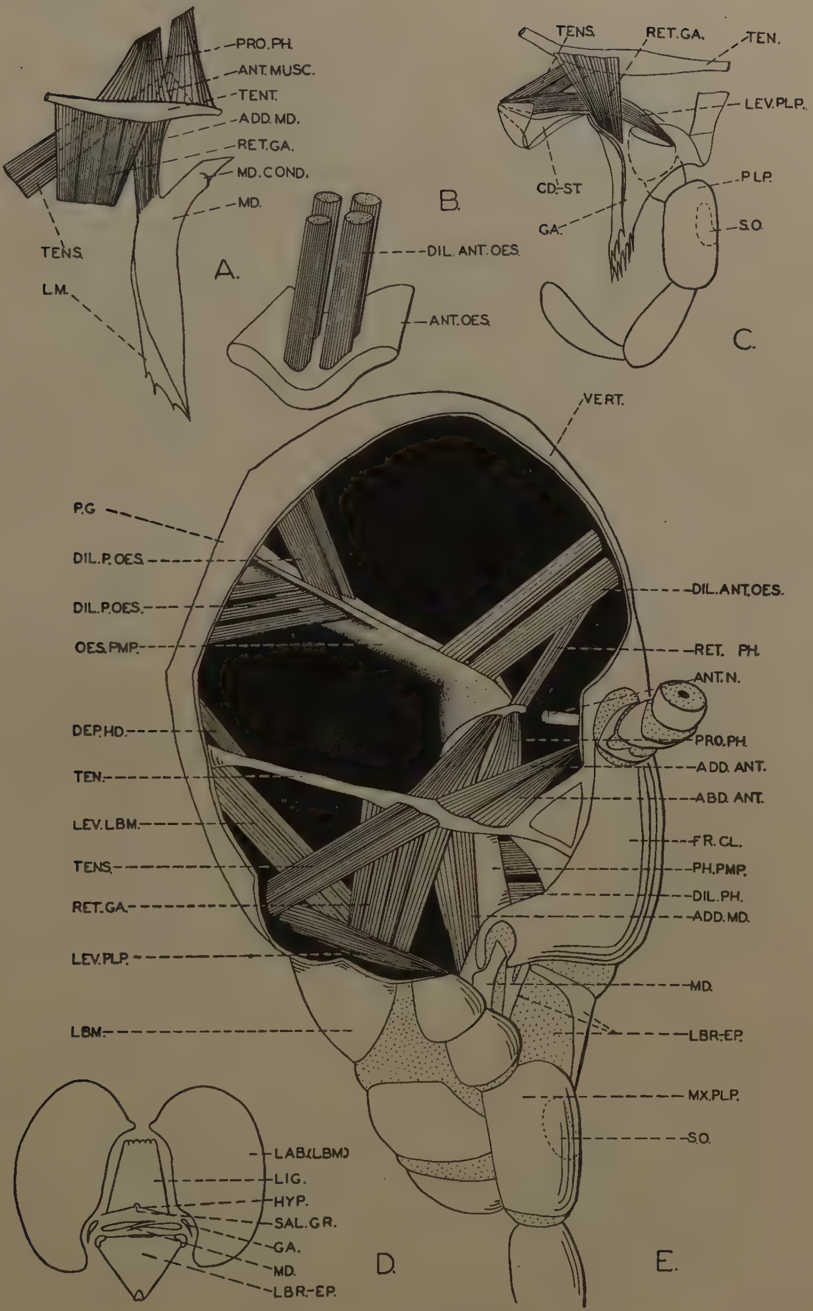
Explanation of Plate I

Eusimulium lascivum

A. Mesal aspect of the mandible, tentorium, and associated musculature of female.
B. Anterior portion of the oesophageal pump of female, with its musculature.
C. Mesal aspect of the maxilla, tentorium, and associated musculature of female.
D. Cross-section through the mouthparts of female, at the level of the second labial segment.
E. Lateral aspect of the musculature of the head of female as it appears with a portion of the head wall removed.

Explanation of Abbreviations

A. ADD. MD.—Accessory adductor of the mandible.
ABD. ANT.—Abductor of the antenna.
ABD. MD.—Abductor of the mandible.
ADD. ANT.—Adductor of the antenna.
ADD. MD.—Adductor of the mandible.
ANT.—Antenna.
ANT. MUSC.—Antennal muscle.
ANT. N.—Antennal nerve.
ANT. OES.—Anterior oesophageal pump.
ANT. W. PH.—Anterior wall of the pharynx.
CD.-ST.—Cardo and stipes.
COMP. LBR.-EP.—Compressor of the labrum-epipharynx.
DEP. HD.—Depressor of the head.
DIL. ANT. OES.—Dilator of the anterior oesophageal pump.
DIL. PH.—Dilator of the pharyngeal pump.
DIL. P. OES.—Dilator of the posterior oesophageal pump.
DIL. SAL. PMP.—Dilator of the salivary pump.
E.—Eye.
F. M.—Foramen magnum.
FR.-CL.—Fronto-clypeus.
GA.—Galea.
HYP.—Hypopharynx.
LAB.—Labella.
LBM.—Labium.
LBR.-EP.—Labrum-epipharynx.
LEV. LBR.—Levator of the labrum-epipharynx.
LEV. LBR.-EP.—Levator of the labrum-epipharynx.
LEV. LBM.—Levator of the labium.
LEV. PLP.—Levator of the maxillary palpi.
LIG.—Ligula.
LM.—Lamella.
MD.—Mandible.
MD. COND.—Mandibular condyle.
MX. PLP.—Maxillary palp.
OC.—Occiput.
OC. CON.—Occiputal condyle.
OES. PMP.—Oesophageal pump.
O. LEV. PLP.—Origin of the levator of the palp.
PED.—Pedicel.
P. G.—Postgena.
PH. PMP.—Pharyngeal pump.
PLP.—Maxillary palp.
P. OES.—Posterior oesophageal pump.
PRO. PH.—Protractor of the pharyngeal pump.
P. W. PH.—Posterior wall of the pharynx.
RET. GA.—Retractor of the galea.
RET. PH.—Retractor of the pharyngeal pump.
SAL. CH.—Salivary channel.
SAL. D.—Salivary duct.
SAL. G.—Salivary gland.
SAL. GR.—Salivary groove.
SAL. PMP.—Salivary pump.
SC.—Scape.
S. O.—Sensory organ.
TENS.—Tensor muscle.
TENS. FR.-CL.—Tensor of the fronto-clypeus.
TEN.—Tentorium.
TENT.—Tentorium.
TH.—Theca.
VERT.—Vertex.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LM.). In several places along its widest part it is further produced into a few short serrations. The lamella begins below the insertion of the adductor muscle of the mandible (Pl. I, fig. A; ADD. MD.).

Musculature. In *Eusimulium lascivum* the mandible is served by only one muscle, the adductor. It arises on the inner, lower side of the anterior arm of the tentorium below the origin of the antennal muscles and before that of the retractor of the galea. It is inserted on the mesal edge of the mandible about one fourth of the distance from the proximal end (Plate I, figs. A and E; ADD. MD.).

In *Prosimulium magnum* there are two additional muscles. One of these is the abductor of the mandible. Its origin is on the postgena. It tapers sharply, the apex giving rise to a long tendon which is inserted on the proximal end of the mandible (Plate II, fig. F; ABD. MD.). The other is an adductor of the mandible. It arises on the postgena above the abductor. Like the abductor it tapers and gives rise to a long tendon which runs across the mesal face of the abductor muscle and is inserted on the mesal edge of the mandible below the insertion of the other adductor which latter corresponds to the adductor of the mandible of *E. lascivum* (Plate II, fig. F; ADD. MD.; A. ADD. MD.). In *E. lascicum* the two large muscles are not present although there was a vestige of the abductor muscle in one dissection.

The Maxillae. Each maxilla consists of a palpus, a galea, and what appears to be the fused cardo and stipes (Plate I, fig. C; II, fig. E). These parts are joined together by the membrane which is common to all the mouthparts. The sclerites of the fused cardo and stipes are attached to the posterior wall of the head capsule above the attachment of the labium. Each is surrounded laterally and dorsally by the postgena, (Plate II, fig. E; CD.-ST.). The anterior extension of the fused sclerites of each side is joined to the membrane which binds the first segment of the palpus to the head capsule and which is continuous with the proximal end of the galea (Plate II, fig. E).

The palpus is four segmented with the first segment subdivided. The second segment has a deep pit in which is probably located a sensory organ, (Plate I, figs. C, E; S. O.).

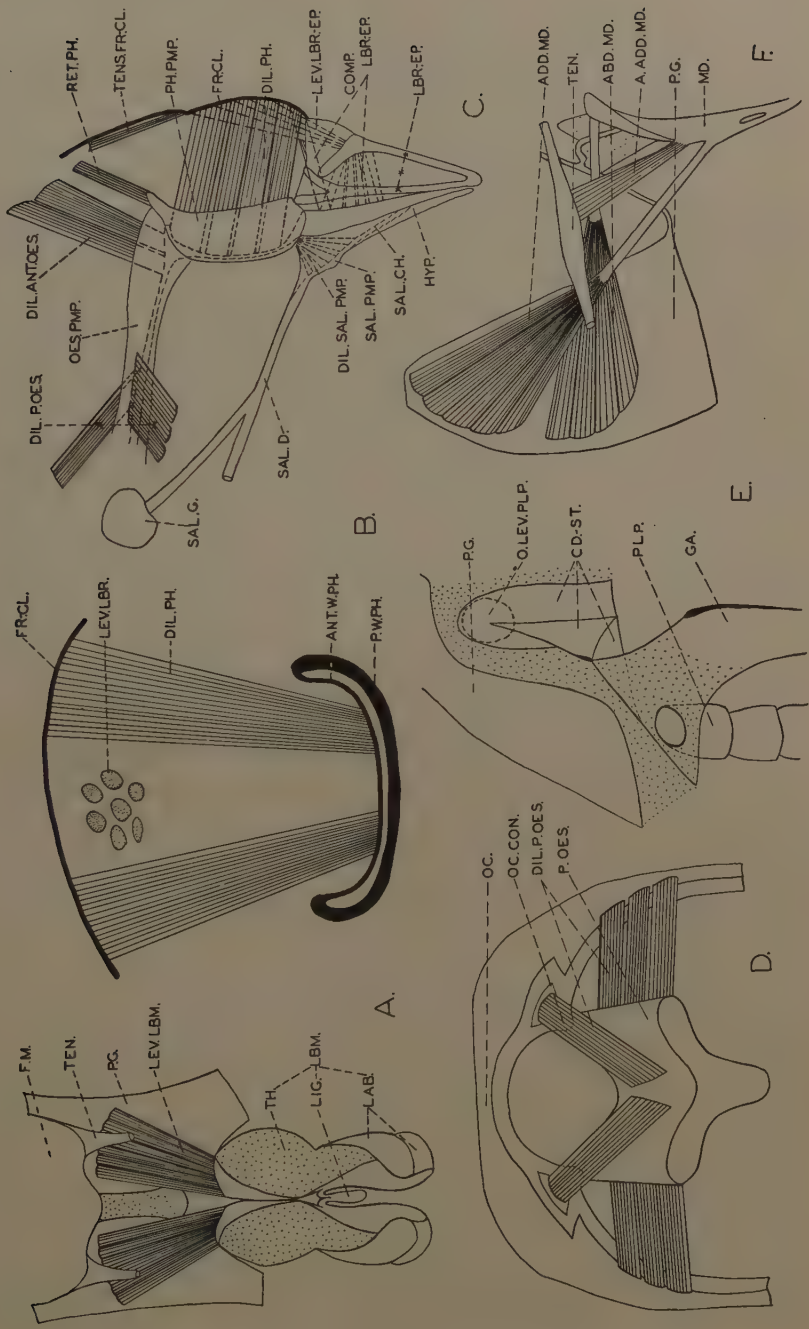
The galea is bladelike and strongly concave anteriorly. It tapers gradually from its proximal end to the distal and terminates in a rounded point armed with spinelike projections, (Plate I, fig. C; GA.).

EXPLANATION OF PLATE II

Figs. A–E, *Eusimulium lascivum*

Fig. F, *Prosimulium magnum*

A. Cephalic aspect of the labium and associated musculature of female.
B. Cross-section through the pharyngeal pump, one pair of dilator muscles, and the levator muscle of the labrum of female.
C. Lateral aspect of the pharyngeal pump, oesophageal pump, salivary pump, one salivary gland, hypopharynx, labrum-epipharynx, and the associated musculature with the exception of the protractor muscles of the pharyngeal pump of female.
D. Posterior portion of the oesophageal pump of female with its musculature.
E. Cephalic aspect of the maxilla of female with the musculature removed.
F. Mesal aspect of the mandible and tentorium of *Prosimulium magnum* (female) with its associated musculature.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DIL.P.OES.
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P.OES.
D.

Musculature. The levator muscle of the palpus arises on the upper end of the fused cardo and stipes at the point of junction with the head capsule (Plate II, fig. E; O. LEV. PLP.). It is inserted on the upper anterior edge of the first segment of the palpus at the line of its junction with the membrane (Plate I, figs. C and E; LEV. PLP.).

The retractor muscle of the galea is a broad group of short muscles whose origin is on the inner and under side of the tentorium posterior to the origin of the adductor of the mandible. It is inserted near the mesal edge of the proximal end of the blade (Plate I, figs. C and E; RET. GA.).

A muscle associated with the maxillary musculature takes its origin on the lateral face of the tentorium beside the origin of the retractor of the galea. It is inserted on the head capsule above and laterad to the origin of the levator of the palpus (Plate I; figs. C and E; TENS.).

The Labium. The labium consists of two lobes each of which is concave anteriorly, especially at the distal two thirds, so that the other mouthparts are concealed therein when at rest (Plate I; fig. E; II; fig. A; LBM.). Each lobe is composed of three segments. The proximal segment of one lobe is fused to that of the other along the posterior midline, while the remaining segments lie free. According to Jobling (1928) the fused basal segments constitute the theca while the free segments are the labella (Plate II; fig. A; TH., LAB.). At the inner distal ends of the proximal segments lies the ligula (Plate II; fig. A; LIG.).

Musculature. Each lobe of the labium is provided with a single muscle. The muscle for each lobe arises on the postgena below the posterior arm of the tentorium and is inserted on the turned in margin of the basal segment (Plate I; fig. E; II, fig. A; LEV. LBM.). This muscle probably acts as the levator of the labium.

The Hypopharynx. The hypopharynx is an elongate, triangular blade. It is suspended from the posterior wall of the pharyngeal pump. The proximal portion of its posterior surface has attached to it the salivary pump (Plate II; fig. C; HYP., SAL. PMP.). The salivary duct pierces diagonally through the hypopharynx and continues along the anterior wall as a groove (Plate I; fig. D; SAL. GR.; II; fig. C; SAL. CH.). The remainder of the posterior wall of the hypopharynx is attached to the ligula of the labium (Plate I; fig. D; LIG.).

THE ANTENNAE

Each antenna is composed of eleven segments and is supplied with two muscles. Both of these take their origin on the dorso-lateral surface of the tentorium. They arise one in front of the other, the anterior slightly overlapping the posterior (Plate I; fig. E; ADD. ANT.; ABD. ANT.). The anterior muscle of the pair is inserted on the lower outer edge of the scape while the other is inserted on the lower inner edge. The first is the abductor of the antenna, the second the adductor. Acting together they would depress the antenna.

THE DEPRESSOR OF THE HEAD

The head is depressed by two long, ribbonlike muscles each of which is inserted on the posterior tentorial arm and arises in the prothorax (Plate I; fig. E; DEP. HD.).

DETAILED DESCRIPTION OF THE PUMPS

The pumps in *Eusimulium lascivum* are the pharyngeal pump, the oesophaegal pump, and the salivary pump. They are all of the same general type in that they are dilated by muscular action and spring back into their normal position by the resiliency of their sclerotized walls.

The Pharyngeal Pump. The pharyngeal pump is a vertical, sclerotized tube lying in the midline of the head just behind the fronto-clypeus (Plate I; fig. E; II; fig. C; PH. PMP.). Its anterior wall is invaginated into the lumen of the pump so that its inner face is almost apposed to that of the posterior wall (Plate II; fig. B; ANT. W. PH.). The anterior wall is continuous with the posterior wall of the labrum-epipharynx at its lower end and with the dorsal wall of the oesophageal pump at its upper end. The posterior wall is continuous with the hypopharynx at its lower end and the ventral wall of the oesophageal pump at its upper end (Plate II; fig. C; PH. PMP.).

Musculature. The pharyngeal pump is served by three groups of muscles; two pairs of protractors, a pair of retractors, and four pairs of dilators. Each pair of protractor muscles of the pharyngeal pump arises on the tentorium beside the origins of the antennal muscles and above those of the adductor of the mandible and retractor of the galea. The pair is inserted on the dorso-lateral edge of the posterior wall of the pharyngeal pump near the line of junction with the oesophageal pump (Plate I; figs A and E; PRO. PH.).

The two retractor muscles of the pharyngeal pump originate on the vertex between the origins of the dilators of the anterior end of the oesophageal pump. Each is inserted on one of the upper anterior corners of the pump (Plate I; fig. E; II; fig. C; RET. PH.).

The dilator muscles of the pharyngeal pump take their origin on the fronto-clypeus and are inserted on the anterior wall of the pump (Plate I; fig. E; II, C; DIL. PH.).

The protraction and retraction of the pharyngeal pump will also cause protraction and retraction of the hypopharynx, and, because of the nature of their attachment, the levation and depression of the labrum-epipharynx.

The Oesophageal Pump. The oseophageal pump continues from the pharyngeal pump at almost a right angle and passes through the brain to the foramen magnum. The pumping portions are in front of and behind the brain (Plate I; fig. E; II; fig. C; OES. PMP.).

The anterior portion of the oesophageal pump has nearly the same cross-sectional structure as the pharyngeal pump, the dorsal wall being almost apposed to the ventral wall (Plate I; figs. B and E; II; fig. C; ANT. OES.). As the pump passes through the brain the cross-sectional structure changes until at its posterior end the dorsal and two lateral walls are invaginated into the lumen forming a somewhat Y-shaped channel in cross section (Plate I; fig. E; II; figs. C and D; P. OES.).

Musculature. The anterior portion of the oesophageal pump is dilated by four muscles whose origins are on the vertex and insertions on the dorsal wall of the pump (Plate I; figs. B and E; II; fig. C; DIL. ANT. OES.).

The posterior portion of the pump is dilated by three muscles. The first, which consists of a group of two, arises on the occiput just above the occipital condyles and is inserted on the dorsal wall of the pump (Plate I; fig. E; II; figs. C and D; DIL. P. OES.). The other two muscles consist of three each. Each group of three originates on the postgena near the edge of the foramen magnum and is inserted on a lateral wall of the pump (Plate I; fig. E; II; figs. C and D; DIL. P. OES.). Dilation would be accomplished by the three muscles pulling in unison.

The Salivary Pump. The salivary pump is a modified and sclerotized portion of the common salivary duct before it passes into the hypopharynx. The duct is dilated and has the upper wall invaginated into the lumen. The lateral edges formed by this invagination are attached to the hypopharynx (Plate II; fig. C; SAL. PMP.). The dilator muscle of the salivary pump arises on the midline of the lower end of the posterior wall of the pharyngeal pump. It is inserted on the invaginated wall of the pump (Plate II; fig. C; DIL. SAL. PMP.).

SUMMARY

The author has studied the mouthparts and associated musculature of *Eusimulium lascivum* Twinn. Though the above description is specifically for the female, it would do as well for the male since the two are almost identical in the structures described.

In all there are eighteen groups of muscles which consist of a total of forty-seven individual muscles. These appeared consistently in more than seventy-five dissections. In addition there are some vestigial muscles which occurred only in a few specimens. These vestiges correspond to functional muscles in *Culicoides pulicaris* as described by Jobling (1928), and also to muscles present in *Prosimulium magnum* as studied by the writer. The absence of some of these important muscles, especially the mandibular muscles, seems to indicate that *Eusimulium lascivum* does not take blood.

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A NEW TROGLODERUS FROM NEVADA, WITH A KEY TO THE KNOWN SPECIES

(COLEOPTERA: TENEBRIONIDAE)

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The genus *Trogloderus* was erected by Le Conte in 1879, to receive the newly-described *costatus* from Idaho. In 1883, Le Conte and Horn erroneously restricted the species to "Nevada," but Dr. Blaisdell, in 1909, extended the distribution to "Western Nevada and the contiguous eastern California." In the same publication, Dr. Blaisdell described a new species, *tuberculatus*, from a single specimen in the U. S. National Museum from Los Angeles County, California.

While collecting over the sand dunes of northern and central Nevada during the summer of 1941, the author took ten individuals of an undescribed species which, from present meager observations, seems to be restricted to sanded areas. The following key (adapted from Blaisdell, 1909) will separate the three species of the genus:

Pronotum tuberculate. . . . . **tuberculatus**
Pronotum reticulate.
  Pronotal median foveae deep, distinct, separate; larger, averaging 11.5 mm. **costatus**
  Pronotal median foveae absent or faint and connected, appearing as a shallow furrow; smaller, averaging 9.1 mm. . . . . **nevadus**

The author wishes, at this point, to acknowledge his indebtedness to Dr. Blaisdell, whose generous and kindly aid has made possible the following account.

Trogloderus tuberculatus Blaisdell

Trogloderus tuberculatus Blaisdell, 1909, U. S. N. M. Bul. 63, pp. 490–492; pl. 6, fig. 14.

This distinctive species, described from a solitary female collected by D. W. Coquillett in Los Angeles County, California, has since been found in two other states. Seven specimens in the collection of the California Academy of Sciences represent four new localities:

Nineteen miles southwest of Kayenta, Navajo County, Arizona, at 6,500 feet, two specimens collected June 17, 1933, and one on June 18, 1933, by H. N. Hultgren, of the Ansel F.

Hall Expedition, 1933; Mojave, California, one specimen in the Van Dyke collection, taken May 1, 1937; Willow Tank, Escalante Desert, Kane County, Utah, two specimens collected during June of 1936, by V. M. Tanner; Utah, one specimen in the Fenyes collection, taken in August of ?.

Like *costatus*, this species possesses two well-defined median foveae on the pronotum, and none of the specimens examined showed any tendency towards foveal obliteration or coalescence.

Trogloderus costatus Le Conte

Trogloderus costatus Le Conte, 1879, N. A. Entomologist, January 1, p. 3; pl. 1, fig. 3.

In his description of the species, Le Conte listed the following specimens: "Rock Creek, Owyhee County, Idaho. Mr. Charles Lichtenfeld; one specimen kindly given me by Mr. Reinecke; others are in the collections of Dr. Horn and Mr. Bolter." The California Academy of Sciences collection contains the following records: Wendall—Gooding, Idaho, one specimen collected on April 5, 1931, by J. C. Chamberlin: Lake Tahoe, California, two specimens collected on July 4, 1941, by Kenneth S. Hagen; Truckee, California, one specimen taken at the State quarantine station by inspectors, a specimen which may have come from adjacent Nevada.

The author has Nevada specimens from Douglas County (Minden), Humboldt County (Paradise Valley sand dunes), Washoe County (Truckee Meadows, Washoe Lake dunes). In the vicinity of Reno (Truckee Meadows), the species is taken most frequently along river bottoms during moderate winters while they are hibernating, and practically all specimens so collected are encrusted to some degree with mud, which usually obliterates the finer, and sometimes all, sculptural details. In 1909, Dr. Blaisdell could only record the species' habitat as "arid regions," but information accumulating since then indicates that *costatus* is equally at home in more humid situations; in fact, as mentioned above, they occur, as accurately as three years of collecting can determine, only along streamways in the vicinity of Reno, where the author is most familiar with the species. Specimens from Minden were taken in equally moist situations near the eastern face of the Sierra Nevada Mountains. Individuals from the sanded northeast side of Washoe Lake, and from the sand dunes in the southwest corner of Paradise Valley, however, were inhabitants of typically arid regions. The Paradise Valley specimens were taken only on the shaded, eastern edge of the dunes in late afternoon, where they were feeding on shrubs and characteristic annuals of the dunes, associated with *Sphaeriontis muricata*, *Eleodes obscura sulcipennis*, *E. longipilosa*, *E. nigrina*, and *E. pilosa*. The associated streamway fauna, as would be expected, presents a different facies, and is distinguished by such species as *Eleodes tenebrosa tenebrosa*, *E. t. nana*, *E. pilosa*, *E. nigrina*, *Helops californicus*, *Blapstinus crassicornis*, *Calendra vomerina*, and *Cardiophorus fenestratus*.

Trogloderus nevadus n. sp.

The following description is patterned after the form established by Dr. Blaisdell.

General: Elongate, oblong-oval, opaque, reddish-brown to purple-black; pronotum reticulate; elytral costae acutely elevated; total length 8 mm. to 11 mm.

Head: Rough, irregularly impressed to smooth, tuberculate; frontal ridge weak to prominent, arcuate, connecting antennal bases; median, longitudinal head ridge single, weak, wide to double, parallel, strong, and narrow, flanked by weak depressions which extend laterally almost to the eyes.

In two specimens, the head is typically rough and irregularly impressed. The remainder possess a smoother surface, dotted to varying extents with small tubercles. The smoothest example possesses a perfectly clear, narrow strip bordering the weak frontal ridge posteriorly, the remainder of the head beset with small tubercles, while the median ridge is obsolete. Several individuals show the median ridge suppressed into two parallel, thin but definite, ridges which bow laterally, forming two isolated, concavely-opposed crescents occupying the center of the head, the intervening and flanking areas being relatively smooth, while the frontal ridge is prominent, and the epistoma more or less hourglass-shaped, each end scooped out, the entire plate weakly tuberculate. In the fourteen specimens examined, the head varies from 2.7% longer than wide to 33.4% wider than long, the average being 17.2% wider than long.

Pronotum: Widest at the middle, disc strongly convex in transverse section, finely reticulate, each reticule generally possessing a minute puncture. Two median foveae entirely absent or reduced to faint, connected depressions, forming a weak, longitudinal furrow extending from the anterior edge of the pronotum three-fourths of the distance to the posterior edge. Pronotal margins reflexed, most prominently along posterior, arcuate border. Lateral margins serrate anteriorly, roughened posteriorly, and entire margin darker than disc.

In two of the specimens, a coalescing of the reticules was noted, especially in the anterior central portion of the disc, and in one individual, a slightly widened posterior end of the median furrow suggests the large, hind fovea of *costatus;* in another specimen, the furrow is obliterated except for a slight suggestion of the anterior *costatus* fovea, and effect produced by the fusion of several reticules, thus eliminating the intervening ridges and forming a very faint depression. Such characters, however, are visible only under strong magnification. In the specimens examined (14), the pronotum varies from 13.7% to 24.8% wider than long, averaging 18.1%.

Elytra: Widest at, or slightly forward of, middle; base lacking margin, and slightly narrower than opposed prothoracic margin; humeri obsolete; disc strongly convex in transverse section, sutural costae weak, not equalling strongly developed discal and humeral costae, which are weakly and widely serrate on top, the teeth pointing caudad, and each tooth bearing a tiny seta at the posterior base; intercostal spaces weakly punctate; all costae ending free at apical declivity, humeral costae not distinctly longer than remaining costae. The elytra varies from 31.3% to 42.9% longer than wide, averaging 35.3%.

Propleurae: More systematically punctate than the intercostal spaces, the punctures arranged in distinct longitudinal lines. Otherwise smooth and slightly convex in transverse and longitudinal sections.

Ventrum: Nearly smooth, weakly beset with fine, widely-spaced tubercles.

Legs: Smoother, but similar in all points to *costatus* (see Blaisdell, 1909).

Male—The solitary male in the lot is 8 mm. long; profemora armed with a low, blunt tooth distally, protibiae bearing a wide, broad tooth proximally, giving the segment the appearance of being rapidly constricted near the base.

Females—Vary in size from 8 to 11 mm., averaging 9.3 mm. in length; only one specimen measured 8 mm., the remainder being larger than the solitary male; profemora and protibiae obsoletely toothed.

Genitalia: Similar to *costatus*, but smaller, the solitary male *nevadus* apicale comparatively shorter, being only 34.7% of the total edeagophore length, while *costatus* apicales examined average 40% of the total edeagophore length, none being less than 39.4%.

Affinities: Trogloderus nevadus exhibits close relationship to *T. costatus*, especially specimens of the latter collected at the Paradise Valley dunes. These dune *costatus* approach *nevadus* in finer sculpturing and smaller foveae, but none exhibit typical *nevadus* details, such as fused, obsolescent foveae and elytral punctation. It is possible that a larger series of *nevadus* might show forms intergrading with *costatus*, for there is much of Nevada which has yet to be collected over, but the fourteen specimens studied exhibit distinct specific characters, and could not be confused with even the dune *costatus*. Quite obviously, *nevadus* is a specialized *costatus*, apparently isolated from that species at one time by the vagaries of the inland seas and lakes which have occupied the Great Basin in the geologic past. Now, however, with the vanishing of the isolating factor, the two species have again come in contact, a line of contact which has so far been demonstrated only in regions occupied by dunes and loose sands.

Habitat: West central and southern Nevada, apparently restricted to sand dune areas. The following localities have yielded specimens: Paradise Valley sand dunes, one specimen, taken on June 18, 1941, by Ira La Rivers (Calif. Acad. Sci. col.); Pyramid Lake sand dunes, seven specimens (one male, six females, September 1, 1941, Ira La Rivers and Thomas Trelease (author's col.); Pyramid Lake, one specimen, collected May 19, 1923, in Blaisdell Collection (Calif. Acad Sci. col.); Truckee, California, four specimens taken at the State quarantine station by inspectors (one on March 3, 1930), and donated by G. R. Wilson. From available evidence, it is very probable that these came from adjacent Nevada (Calif. Acad. Sci. col.); Thorne sand dunes (Mineral County), two specimens, July 7, 1941, Ira La Rivers, (one in author's col., other in Calif. Acad. Sci. col.); Esmeralda County, one specimen, March 19, 1908, F. W. Nunenmacher, in Van Dyke Collection (Calif. Acad. Sci. col.); Goldfield, Esmeralda County, one specimen, June 26, 1907, F. W. Nunenmacher, in Blaisdell Collection (Calif. Acad. Sci. col.).

Types: Holotypic male (Pyramid Lake), allotype (Thorne), and four paratypes (Pyramid Lake), in the author's collection; four paratypes in the collection of the California Academy of Sciences; one paratype each in the collections of the U. S. National Museum and the American Museum of Natural History.

Habits: Practically nothing is known of the life history of the species. They possess, in common with the *T. costatus* collected in similar arid situations, the habit of rigidly feigning death when disturbed, and all the specimens taken were observed to place the middle legs fixedly at right angles to the longitudinal axis of the body, disposing the other two pairs of legs so each formed an approximate 45 degree angle with the middle legs and body. At Pyramid Lake, *T. nevadus* was found associated with *Sphaeriontis muricata*, *Eleodes armata*, *E. grandicollis valida*, *Cryptoglossa verrucosa inyoensis*, and *Blapstinus crassicornis*, with similar associations at Thorne. At the Paradise Valley sand dunes, *nevadus* was found with *costatus*, the only region in which the association of the species has been demonstrated.

Russian thistle (*Salsola pestifer*) grows prolifically on the low Pyramid Lake dunes, and many of the characteristic dune inhabitants use the weed for food and shelter. Like the others, *nevadus* avoids the heat of day, and is most in evidence in the late afternoon on the shady (east) side of the dunes.

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Le Conte, John L. 1879. New North American Coleoptera. North American Entomologist, p. 3, pl. 1, fig. 3.

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STUDIES IN THE GENETICS OF DROSOPHILA. II. GENE VARIATION AND EVOLUTION. Directed by John T. Patterson. pp. 1–200, 7 x 10 inches, paper bound. The University of Texas Publication, No. 4228. Published by The University of Texas, Austin, Texas. Price $1.00.

The first publication in this series, which appeared in 1940, dealt primarily with the effects of aneuploidy and chromosomal aberration on the phenotype, viability, and fecundity of *Drosophila;* the present publication consists of ten papers dealing with gene variation and evolution; written by various members of the group working in the genetics laboratory of the University of Texas.

The scope of this publication is indicated by the paper titles: Interspecific hybridization in the genus *Drosophila;* Heterosis in *Drosophila hydei;* Analysis of the *repleta* group of *Drosophila;* Cross fertilization and isolating mechanisms in the *Drosophila mulleri* group; Relationships in the *melanica* species group; Genetic relationships in the *Drosophila funebris* group; A study of intersexes produced by a dominant mutation in *Drosophila virilis*, *blanco* stock; The Ix^B factor and sex determination; Distribution of the *virilis* group in the United States; Genetic and cytological analysis of the *virilis* species group.

This publication should be of interest to entomologists in that it presents a detailed analyses of some of the genetic factors that have been in operation in the evolution of the flies of the genus *Drosophila*. Few entomologists can experiment with their material to the extent that geneticists have done with *Drosophila*, but an understanding of the processes at work in *Drosophila* may help to clarify the problems encountered in other animal groups.—D. J. Borror.

NOTES ON TABANIDAE (DIPT.) FROM PANAMA

X.[1] THE GENUS TABANUS LINN., AND RESUME OF THE TABANIDAE OF PANAMA[2]

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Genus **Tabanus** Linnaeus

1758, Syst. Nat., 10th ed., p. 601. Latreille, 1810, Consider. General, p. 443 (Type, *T. bovinus* Linn.). Kertész, 1908, Cat. Dipt., III, p. 217. Surcouf, 1921, Gen. Insect., Fasc. 175, Taban., p. 54. Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 347; Op. cit., 1925, XI, 2, p. 355. Bequaert, 1930, The African Republic of Liberia and the Belgian Congo, II, p. 903. Kröber, 1934, Rev. Ent., IV, 3, p. 292.

There seems no good reason for including the many references to the name to be found in the literature, nor do I feel it wise to list the numerous names which have been placed in the synonymy of *Tabanus* by various authors. Names in this group are being removed from and replaced in the synonymy so often that it seems better not to further complicate matters.

A single species, *T. globulicallosus* Kröber (Stett. Ent. Zeit., XCII, p. 302) has been omitted, as, although described from Panama, I have been unable to recognize it from the description.

KEY TO SUBGENERA OF TABANUS

1. Pre-scutellum and disc of scutellum densely covered with black pubescence which is more or less completely surrounded by a ring of white pubescence. Eyes bare. Vertexal tubercle weakly developed or absent in the female, present in the male. . . . . **Bellardia**
No black pile on scutellum, rarely a small tuft on pre-scutellum. 2
2. Wings prominently clouded with brown, rarely largely black, generally with the cross-veins surrounded by hyaline fenestrae. Frons mostly very narrow, the callus ridge like. Eyes bare, unbanded in life, **Philipotabanus**
Wings fumose, hyaline, entirely black or spotted on the cross veins, or frons otherwise. 3
3. Abdomen with 1 or 3 pale longitudinal stripes or rows of truncate contiguous triangles. Fore tibiae bicolored. Eyes bare in the female, bare or hairy in the male, green with 2 or 3 dark bands in life. Wings hyaline, fumose or with faint clouds on cross veins. . . . . **Neotabanus**
Abdomen unstriped, or eye with but one band in life. 4
4. Eyes definitely pilose in both sexes, generally dark with 2 or more green bands in life. Vertexal tubercle present, usually prominent. . . . . **Hybomitra**
Eyes bare in the female, or vertexal tubercle absent. . . . . **Tabanus**

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[1] Part IX these Annals, September, 1942, p. 289.

[2] Printing costs paid in full by the Gorgas Memorial Institute, Washington, D. C.

KEY TO FEMALES OF TABANUS

1. Wholly black species with deep black wings. Third antennal segment with a rather long tooth dorsally and a prominent angle below. Large species 20 mm. or more long....................................**erebus**

Not black species, the wings hyaline or fumose............................2

2. Prescutellum with a small tuft of black pubescence. Large brown species mostly over 15 mm. long, the antennae with a strong dorsal tooth, the abdomen with 2 or 3 rows of light spots..............................3

Prescutellum concolorous with rest of thorax..............................4

3. Palpi exceedingly short and thick. Abdomen brown, dark haired, but with a pair of pale haired dorsolateral stripes formed of large confluent rounded spots extending from the first to sixth tergites.........**importunus**

Palpi stout, but the apex drawn out into a slender point. Abdomen with a median series of pale haired triangles as well as the dorsolateral series, the latter of smaller, less confluent spots....................**ferrifer**

4. Frons very narrow, callus ridge like, third antennal segment with a strong dorsal tooth. Legs black, abdomen orange rufous, the terminal segments often black. Wings strongly smoky. Large species, generally over 15 mm..**bigoti**

Smaller more slender species, seldom reaching 15 mm. Legs not wholly black. Frons broader, the callus at most club shaped.....................5

5. Wings, including the costal cell, entirely hyaline. Frons quite broad, the callus as wide as high..6

Wings fumose, or the veins brown margined, or the costal cell yellowish or brownish. Frons narrower, the callus generally higher than wide.........7

6. Annulate portion of third antennal segment longer than basal portion. Frontal callus yellow, rounded, rather flat. Thorax grey, rather prominently striped. Abdomen dark with a row of pale grey median triangles and a pair of dorsolateral rows of oblique grey patches..........**praepilatus**

Annulate portion of third antennal segment shorter than basal part. Frontal callus black, rather protuberant. Thorax unstriped. Abdomen yellow, with three rows of faint pale haired spots.............**rhizophorae**

7. Antennae exceedingly slender, the third joint wholly black, with the short dorsal tooth very close to the base. Slender, long winged species, the wings evenly fumose, the abdomen brown, with a median row of non-contiguous pale haired triangles.........................**umbraticolus**

Smaller, stouter species, the wings with all veins narrowly brown margined, the antennae with third joint largely or wholly yellow, stouter, and the abdomen not so marked...8

8. Abdomen yellow, dark haired, and with a prominent broad median yellow haired stripe from base to apex, rarely with indications of faint lateral stripes..**rixator**

Abdomen dirty brownish yellow, with three very faint narrow pale haired stripes...**nereus**

Tabanus bigoti Bellardi

(Figs. 4 and 5)

1859, Sagg. Ditt. Mess., I, pp. 58–59 (New name for *T. apicalis* Macq. 1847, nec. Wied. 1828. Description drawn from Macquart's type specimen, which was headless). Osten Sacken, 1886, Biol. Centr.-Amer., Dipt., I, p. 48 (♀; Nicaragua). Hine, 1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 29 (♀; Honduras).

Tabanus apicalis Macquart, 1847, Mém. Soc. Sci. Lille, (1846), p. 36; 1847, Dipt. Exot., Suppl. II, p. 20 (♀; du Mexique). Not *T. apicalis* Wied. 1828.

Tabanus appretiatus Kröber, 1934, Rev. Ent., IV, 3, p. 306 (New name for *T. apicalis* Macq. 1847).

Under this name I include provisionally the species occurring in Panama. There seem to be two very similar forms, but their proper relationships cannot be worked out until much more material from both South and Central America is available. The two forms may be separated as follows:

Antennae largely reddish. Pollinosity of face and frons, and beard yellowish brown. Frontal callus brown. Upper branch of third vein with a long appendix . . . . form A
Antennae largely black. Pollinosity of face and frons, and beard greyish or white. Frontal callus black. Upper branch of third vein without an appendix . . . . form B

Which, if either, of these forms is true *bigoti* it is impossible to say. I have seen specimens very similar to both forms from Honduras and Mexico.

Panama records: Form A. El Valle, Coclé Province, April 13, 1941; May 3, 1942; Cerro Campana, Panama Prov., June 11, 1939; Rio Pequeni, Madden Lake, C. Z., Aug. 21, 1940; Cerro Pirre, Darien Prov., March 18, 1940; Buena Vista, Chiriqui Mt., March, 1926 (J. D. Smith). Form B. Cerro Azul, Panama Prov., May 17, 1941.

Tabanus erebus Osten Sacken

(Fig. 1)

1886, Biol. Centr.-Amer., Dipt., I, p. 50 (♀; Nicaragua and Chiriqui Volcano, Panama). Kertész, 1900, Cat. Taban., p. 48. Williston, 1901, Biol. Centr.-Amer., Dipt., Suppl. p. 257. Aldrich, 1905, Cat. N. Amer. Dipt., p. 203. Kertész, 1908, Cat. Dipt., III, p. 240. Surcouf, 1921, Gen. Insect., Taban., p. 67. Kröber, 1930, Zool. Anz., LXXXVI, p. 298 (=? *Catachlorops* sp.); 1934, Rev. Ent., IV, 3, p. 304 (=? *Phaeotabanus alteripennis* Wlk.).

Astigmatophthalmus satanus Kröber, 1931, Rev. Ent., I, 3, p. 297, fig. 11 (♀; Turrialba, Costa Rica and Chiriqui, Panama); 1934, Op. cit., IV, 2, p. 270. Stone, 1938, U. S. Dept. Agric., Misc. Publ. No. 305, p. 88.

This species is one of the largest in our fauna, and is readily recognized by its wholly black color, including the wings. It seems to be related to the North American *T. atratus* Fab., to which Osten Sacken compared it, and might with some justice be combined with that and related species into a group of subgeneric rank, were it not for a number of species which form perfect intergrades with a large and rather heterogeneous complex of South American forms which are as yet poorly known.

The antennal tooth is very variable in length, and may even reach the first terminal annulus.

Distribution: Recorded from Nicaragua, Costa Rica and Panama. I have seen 6 ♀ from Costa Rica in the Hine Coll.

Panama records: 1 ♀ Barro Colorado Is., May 10, 1926 (Greene); 1 ♀ Cabima, Panama, May 20, 1911 (Busck). 5 ♀ Rio Pequeni, May 11, 1940. 1 ♀ El Valle, Coclé Prov., April 13, 1941. 1 ♀ Cerro Azul, nr. Pacora, May 17, 1941. 2 ♀ El Valle, Coclé Prov., May 3, 1942.

Tabanus ferrifer Walker

(Fig. 3)

1850, Insect. Saund., I, Dipt., p. 30 (♀; ? Barbadoes); 1854, List Dipt. Brit. Mus., V, Suppl. 1, p. 189. Osten Sacken, 1858, Cat. Dipt. N. Amer., p. 21; 1876, Mem. Boston Soc. Nat. Hist., II, pt. 4 (4), p. 476; 1878, Cat. Dipt. N. Amer., 2nd ed., p. 61. Kertész, 1900, Cat. Taban., p. 49. Aldrich, 1905, Cat. N. Amer. Dipt. p. 203. Kertész, 1908, Cat. Dipt., III, p. 241. Surcouf, 1921, Gen. Insect., Taban., p. 68. Dunn, 1929, Am. J. Trop. Med., IX, 6, p. 501 (Baranquilla, Colombia).

Tabanus (*Lophotabanus*) *ferrifer* Kröber, 1930, Zool. Anz., LXXXVI, pp. 262–263, fig. 7 (♀; Venezuela); 1934, Rev. Ent., IV, 3, p. 295 (Barbadoes, Panama, Colombia, Venezuela). Bequaert, 1940, Rev. Ent., XI, 1–2, pp. 298–299, fig. 3; 1940, Bull. Ent. Res., XXX, 4, p. 449 (Trinidad).

Tabanus (*Lophotabanus*) *druyvesteijni* Szilàdy, 1926, Biol. Hung., I, (7) p. 26, Pl. 4, fig. 20 (♂, ♀; Trinidad, Surinam, Panama). Kröber, 1929, Zool. Anz. LXXXIII, pp. 130–131, fig. 10 (Venezuela, Panama, Trinidad, Surinam, Bolivia, Paraguay, Argentina); 1930, Op. cit., LXXXVI, p. 263; 1934, Rev. Ent., IV, 3, p. 295.

Hybostraba ornativentris Kröber, 1929, Konowia, VIII, p. 182, Pl. II, figs. 10, 11. (as synonym of *T.* (*L.*) *druyvesteijni*).

This species and *T. importunus* Wied. appear to be related on the one hand to the subgenus *Bellardia* (*Lophotabanus* Szil.) and on the other hand to a large group of South American species whose relationships are as yet not worked out. *Ferrifer* is fairly abundant in Panama where it flies mainly during the dry season, and on account of its large size constitutes a serious stock pest.

Distribution: I have seen material from British Honduras, Panama, Trinidad, Venezuela and Pará, Brazil. The species is also recorded from Bolivia, Paraguay and Argentina, but all material from that area I have seen personally is a distinct though closely allied species.

Panama records: El Real, Darien Prov., to Capira, Panama Prov., mostly in April, May and June, but scattered captures in Nov., Dec., Jan., Feb., July and August. Apparently quite abundant nearly everywhere.

Tabanus importunus Wiedemann

(Fig. 2)

1828, Auss. Zweifl. Insekt., I, p. 127 (♀; Brasil). Walker, 1854, List Dipt. Brit. Mus., V, p. 219. Kertész, 1900, Cat. Taban., p. 54. Lutz, 1912, Comm. Lin. Teleg. Matto Grosso, Zool., Annexo, 5, p. 4; 1909, Inst. Osw. Cruz em Manguinhos, p. 30. Surcouf, 1921, Gen. Insect., Taban., p. 71. Kröber, 1929, Ann. Mus. Wien, XLIII, p. 246; 1934, Rev. Ent., IV, 3, p. 310. Lutz, 1914, Mem. Inst. Osw. Cruz, VI, 2, p. 70. Fischer, 1933, Rev. Ent., III, 1, p. 134.

Odontotabanus importunus Lutz, 1928, Est. Zool. Parasit. Venezolanas, p. 57. (Venezuela).

Tabanus albidicollis Macquart, 1850, Dipt. Exot., Suppl. IV, p. 32 (Guyana).

Tabanus semisordidus Walker, 1854, List Dipt. Brit. Mus., V, p. 208 (♀; Santarem, Brasil).

This species appears to be fairly abundant locally in the

Republic, though its season of flight, from March to May is rather short.

Distribution: I have seen specimens from the Brazilian states of Amazonas, Pará, Rio de Janeiro and Matto Grosso, and from Paraguay, Venezuela, Surinam and British Guiana. Kröber records it also from Peru.

Panama records: Moja Pollo, Chagres River region, March to May 1940, fairly abundant. 1 ♀ Moja Pollo, Sept. 1, 1940.

Tabanus praepilatus sp. nov.

(Fig. 11)

Female.—Length 11–16 mm., of wing, 11–14 mm.

Eyes bare, dull greenish with a single transverse narrow dark stripe which does not reach the lateral eye margin. Frons broad, about 3¼ times as high as wide, convergent,below, pale yellowish grey pollinose. Frontal callus nearly circular, narrower than frons, yellow to dark brown. Median callus a short unconnected streak, sometimes obsolete. No vertexal tubercle or spot. Subcallus yellowish pollinose, without tubercle or spot, and without erect hairs. Fronto-clypeus and genae greyish pollinose, the latter sparsely white bearded beneath. First two antennal segments straw colored, black haired, not inflated. Basal part of third segment dull brownish, nearly as wide as long, the dorsal angle rather obtuse but with a rather sharp apex. Annulate portion blackish, considerably longer than basal portion. Palpi whitish, dorsally black haired, moderately inflated basally, but slender and pointed apically. Proboscis brown, the labella membranous, short, hardly half length of proboscis.

Mesonotum pale brown with three fairly distinct stripes and the sides grey haired. Scutellum concolorous, grey haired. Pleura and coxae pale grey, white haired. Legs pale brown, whitish pollinose and pale haired, tarsi darker. Wings entirely hyaline; subepaulet with macrotrichia, costa and first vein throughout and subcosta in the middle above with macrotrichia, and often a few hairs on the base of the second vein. Beneath only the costa and subcosta are setose. No appendix on upper branch of third vein. Abdomen greyish brown, black haired, and with a row of rather broad contiguous grey mid-dorsal truncate triangles, a dorso-lateral row of contiguous oblique grey patches, and the sides and hind margins of the segments grey. Beneath the venter is uniformly pale grey pollinose and whitish haired.

Holotype ♀ and 1 ♀ Paratype from Bejuco, Panama Province, Panama, April 21, 1940. 1 ♀ Paratype, same locality, June 18, 1939. 4 ♀ Paratypes Aguadulce, Coclé Province, Panama, August 10, 1940 (C. M. Johnson coll.); 1 ♀ Corozal, C. Z., June 29, 1911 (A. Busck, in U. S. N. M.). Holotype and 2 Paratypes to be deposited in the M. C. Z., Harvard University, Cambridge, Mass. Other Paratypes in author's coll. and U. S. N. M.

This species appears to have no very close relatives in Panama, but approaches in general appearance certain Nearctic species such as *abactor* Philip and *erythraeus* Big., from which it differs in broader frons, and details of antennal shape and color pattern.

Tabanus nereus sp. nov.

(Fig. 9)

Female.—Length 9–11 mm., of wing, 9.5–10.5 mm.

Eyes bare, in life green with a narrow transverse median band and the lower margin purple. Frons moderately broad, about 3½ times as high as wide, very slightly narrowed below, and covered with yellowish brown pollen. Frontal callus rounded to pear shaped, higher than wide, a little more than half as wide as frons, dull yellow. Median callus a short streak unconnected with the basal callus. Vertexal tubercle entirely absent. Subcallus greyish brown pollinose, without hairs. Fronto-clypeus and genae grey, sparsely white haired. First and second antennal segments moderately inflated, pale brownish, black haired. Basal part of third segment reddish, longer than broad and longer than the concolorous annulate portion; dorsal angle well marked but obtuse. Palpi white, somewhat inflated basally, the apical two thirds very slender, blunt pointed and almost spatulate or clubbed, hairs mostly black and rather long. Proboscis brownish, the membranous labella more than half the length of the proboscis.

Mesonotum dull yellowish brown with a sparse vestiture of yellowish hairs but no distinct stripes. Scutellum concolorous. Pleura, sternum and coxae greyish pollinose and sparsely white haired. Legs pale brown or yellowish, the tarsi dusky. Femora pale haired, tibiae and tarsi dark haired. Wings with subepaulet, costa, subcosta and basal section of fifth vein with macrotrichia above, only costa and subcosta hairy beneath. Wings lightly fumose, all veins narrowly dark margined. No appendix on upper branch of third vein. Abdomen dirty yellowish brown, dark haired, and with three very faint stripes of paler hairs on the first to fifth tergites. Venter pale pinkish grey, immaculate.

Holotype ♀, Thatcher Ferry, Balboa, C. Z., June 27, 1939. 2 ♀ Paratypes, Old Panama, Jan. 2, 1941. This little species, although rather inconspicuous, can be quickly separated from

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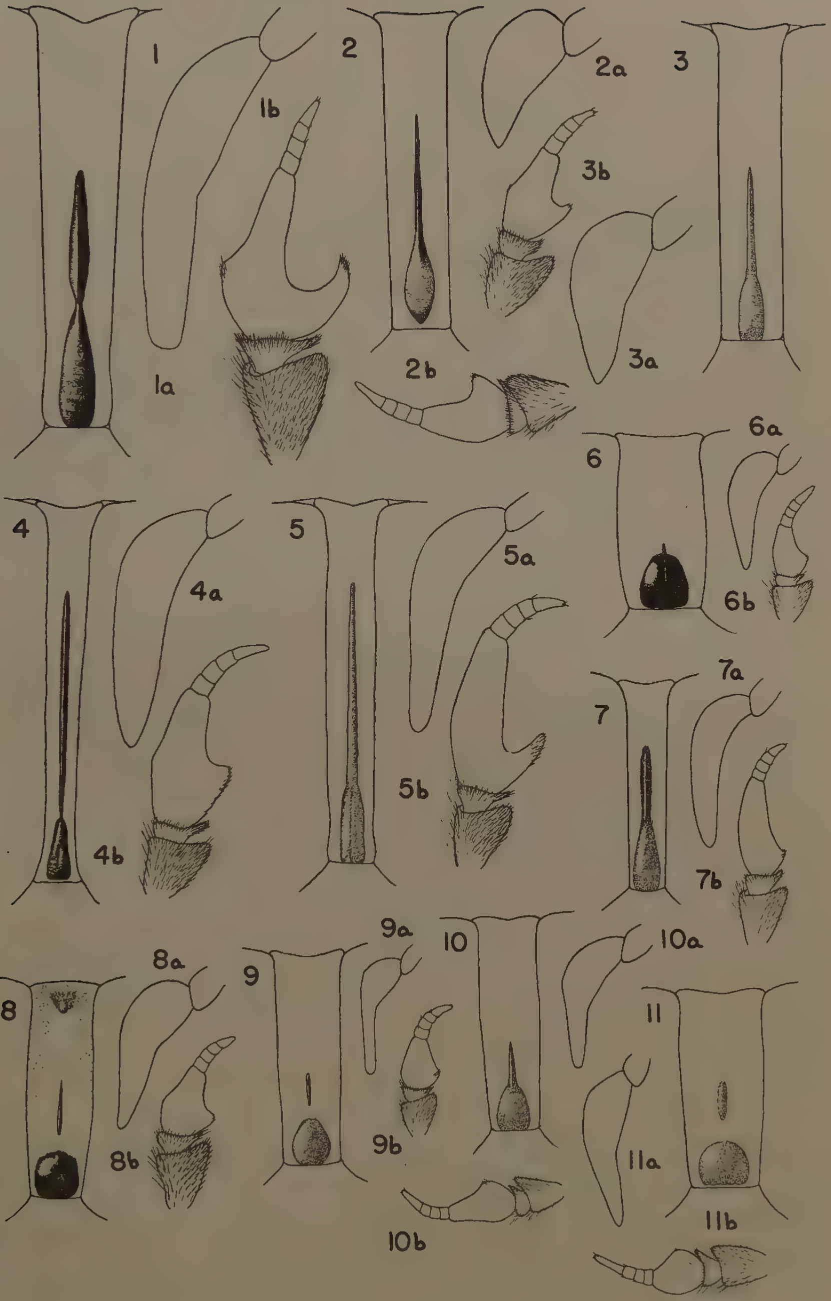
Explanation of Figures in Plate I

All figures are of the frons, antennae and palpi of female specimens, and are all to the same scale. The figures of wings are drawn from specimens mounted in balsam, and are to a somewhat smaller scale than the other figures.

Figs. 1, 1a, 1b—*Tabanus erebus* O. S. 2, 2a, 2b—*T. importunus* Wied. 3, 3a, 3b—*T. ferrifer* Walk. 4, 4a, 4b—*T. bigoti* Bell. form B. 5, 5a, 5b—*T. bigoti* Bell. form A. 6, 6a, 6b—*T. rhizophorae* n. sp. Paratype. 7, 7a, 7b—*T. umbraticolus* n. sp. Paratype. 8, 8a, 8b—*T.* (*Hybomitra*) *quadripunctatus* Macq. 9, 9a, 9b—*T. nereus* n. sp. Paratype. 10, 10a, 10b—*T. rixator* n. sp. Paratype. 11, 11a, 11b—*T. praepilatus* n. sp. Paratype.


1
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10a
10b
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11a
11b

its allies by the unusual palpi. It appears to be related to *rhizophorae* and *rixator* and perhaps to the nearctic group of *nigrovittatus*.

Tabanus rixator sp. nov.

(Fig. 10)

Female.—Length 11–12 mm., of wing, 9.5–10 mm.

Eyes bare, in life uniformly yellowish green, without dark markings. Frons yellowish grey pollinose, about 4¼ times as high as basal width, slightly narrowed below. Frontal callus yellow, higher than wide, pear shaped, narrower than frons, and prolonged above in a slender line about its own length. Vertexal tubercle absent. Subcallus yellowish grey pollinose, without hairs. Fronto-clypeus and genae greyish, dark haired above, white haired below. First two antennal segments very moderately inflated, yellowish, black haired. Basal part of third segment reddish orange, longer than wide, the dorsal angle rather prominent and marked by a tuft of black hairs. Annulate portion concolorous, considerably shorter than basal portion. Palpi whitish, inflated basally, but with a slender apex, mostly black haired. Proboscis pale brown, a little longer than palpi, the labella membranes, over ⅔ length of proboscis.

Mesonotum dark grey, yellowish grey pollinose, unstriped. Scutellum concolorous or slightly paler. Pleura, sternum and coxae pale grey pollinose and white haired. Legs wholly pale brown, the femora pale haired, the tibiae and tarsi dark haired. Subepaulet, costa, subcosta and first and fifth veins above with macrotrichia; all veins prominently brown margined. No appendix on upper branch of third vein. Abdomen light yellowish brown, darker towards apex, dark haired and with a fairly broad (.75 mm.) dull yellow middorsal stripe from first to sixth tergites. In well preserved specimens there is also a pair of faint pale dorsolateral stripes formed of a row of small unconnected rounded spots. Venter pale brown, mostly pale haired.

Holotype ♀ and 1 ♀ Paratype, Paitilla Point, Panama, Republic of Panama, July 7, 1940; 1 ♀ Paratype, Venado Beach, Canal Zone, June 22, 1939; 1 ♀ Paratype, Tapia, Panama Prov., Panama, May 5, 1941; 5 ♀ Paratypes, El Real, Darien Prov., Panama, August 15, 1930 (L. H. Dunn); 1 ♀ Paratype, Rio Abajo, Panama Prov., Panama, 1930 (L. H. Dunn).

The relationships of this little species appear to be with the *nigrovittatus* group of North America, it being especially close to *T. fuscicostatus* of Hine, from which the clear costal cell but brown margined veins will distinguish it. It also might be confused with small specimens of *T. haemogogus* Will., but the yellow uniform stripe and unbanded eyes should serve to distinguish the present species.

Tabanus rhizophorae sp. nov.

(Fig. 6)

Female.—Length 11–12 mm., of wing, 9–10 mm.

Eyes bare, unicolorous, blackish with green reflections in life. Frons pale greyish pollinose with scattered dark hairs, about 2⅓ times as high as the basal width, very slightly wider in the middle than at the base and vertex. Basal callus somewhat higher than wide, about ½ the width of the frons, its lower margin contiguous with the basal suture of the frons, and the upper third narrowed into a fine point that may be drawn out into a short fine line, but which never extends more than half way to the vertex. No vertexal tubercle or bare patch. Subcallus whitish pollinose, without hairs. Antennae pale yellowish, the third segment more orange with the annulate portion dusky. First segment markedly swollen, its apex noticeably wider than the basal part of the third segment. Second segment with a dorsal spine, both segments clothed above with black hairs which are especially dense on the dorsal and distal parts. Third segment relatively narrow and with but a weak and obtuse dorsal angle; the annulate portion somewhat shorter than the basal portion. Clypeus and genae straw colored with white pollen and sparse white hairs. Palpi pure white, markedly inflated basally, but with the apical third abruptly narrowed and drawn out into a slender point. Palpi clothed with rather sparse hairs, black and white mixed in about equal proportions. Proboscis short, longer than the palpi but about equal to the antennae, pale brown, the labella fleshy, without shiny plates, and equalling over ⅔ the total length of the proboscis.

Mesonotum dark grey with whitish pollinosity and short, sparse dark hairs. Sides and venter of thorax yellowish grey with abundant white hairs. Scutellum concolorous with mesonotum, or somewhat reddish distally. Wings completely hyaline, the veins and stigma yellowish. Subepaulet rather inflated and beset with black macrotrichia. The costa, subcosta, and first longitudinal vein beyond the arculus above also bear black macrotrichia. All cells but the anal open. No appendix on third vein. All legs entirely straw yellow, the femora with mostly white hairs, the tibiae and tarsi with black.

Abdomen dirty yellowish grey, without prominent markings. The first two segments are more yellowish, the third to last rather dusky with lighter hind margins. In the best preserved specimen the abdomen is clothed with sparse hairs which are for the most part black, but with very small and indistinct patches of pale hairs indicating a median series of spots and a pair of dorsolateral lines. In all the other specimens, these hairs have been rubbed off so that this faint indication of a pattern has been lost. Beneath the abdomen is as above, but with uniformly pale hairs.

Male.—Coloration as in the female, except that the mesonotum has a slight yellowish tinge, and the abdomen shows three fairly distinct longitudinal stripes of yellow hairs. Eyes contiguous, bare, the large facets occupying somewhat more than ½ the total eye area, not sharply differentiated from the small facets, and the largest facets not more than twice the diameter of the smallest. The tubercle at vertex between the eyes is deeply sunk and barely visible.

Holotype ♀, Allotype ♂ and 5 ♀ Paratypes collected by sweeping saltmarsh grass in a small patch of Mangrove trees on the tide flats between Old Panama and San Francisco de la Caleta, Republic of Panama, May 1, 1939. 1 ♀ Paratype, Paitilla Point, Panama, R. de P., Feb. 1, 1929 (C. H. Curran collector); 2 ♀ Paratypes, Paitilla Point near Panama City, July 7, 1940; 2 ♀ Paratypes, Old Panama, April 20, 1940, Jan. 1, 1941; 1 ♂ Paratype, Old Panama, Dec. 24, 1939. Holotype, Allotype and 2 Paratypes to be deposited in the M. C. Z., Harvard University, Cambridge, Mass. 1 Paratype in the U. S. National Museum, 1 Paratype in the American Museum of Natural History and the other Paratypes in the author's collection.

This and two other species described herein seem to form a group of species which appears to be most nearly related to *T. nigrovittatus* and allies of the Nearctic region. Like their Nearctic relatives, they are frequenters of coastal salt marshes.

Tabanus umbraticolus sp. nov.

(Fig. 7)

Female.—Length 13–16 mm., of wing, 13–14 mm.

Eyes bare, dull bronzy in life, without bands. Frons yellowish grey, a little more than 5½ times as high as wide. Frontal callus yellowish brown, drop shaped, merging imperceptibly into a raised ridge which extends about ⅔ the distance to the vertex. Vertexal tubercle absent. Subcallus yellowish grey pollinose, without hairs. Frontoclypeus and genae pale grey, sparsely pale haired. First antennal segment pale yellowish brown, black haired, rather inflated, wider than the base of the third segment. Basal part of third segment over twice as long as greatest breadth, the dorsal angle acute but short, and very close to base. Annulate portion hardly half length of basal portion. Whole third segment, except extreme base, black. Palpi pale brown, slender, black haired. Proboscis dark brown, less than head height, the membranous labella more than half its length.

Mesonotum light brown, very faintly striped. Pleura, sternum and coxae grey pollinose and white haired. Legs pale brown, the fore femora, apices of tibiae and tarsi a little darker. Wings rather long and narrow, pale smoky brown. Subepaulet, costa and first vein with macrotrichia above, subcosta with a few macrotrichia in the middle. No appendix on third vein. Abdomen orange brown, darker apically, dark haired and with a median row of broad pale yellowish haired triangles on the first to sixth tergites. These triangles do not appear to be contiguous, and apparently are easily lost, as they are fully apparent only in a few of my specimens. Beneath the abdomen is reddish yellow, pale haired and greyish pollinose.

Holotype ♀ and 6 ♀ Paratypes, Boquete, Chiriqui Province, Panama, May 7–10, 1939. 2 ♀ Paratypes, Boquete, March-April, 1941 (Mrs. T. B. Monniche).

This species agrees with a specimen in the Hine coll. (Chiriqui, A. H. Jennings) labelled "*T. simplex* Wlk., comp with type," but it does not agree very well with Walker's description (1850, Insecta Saund., Pt. 1, pp. 34–35, ♀, Colombia). Kröber in his catalogue (1934) places *simplex* as a doubtful synonym of *T.* (*Lophotabanus*) *bifloccus* Hine from Cuba. Hine's type comparisons have not proven infallible, and I prefer to redescribe the present species pending more definite information. The species seems closest to *haemagogus* Will., from which it may be distinguished by narrower frons, more slender antennae, and uncontiguous abdominal triangles.

Subgenus **Hybomitra** Enderlein

1922, Mitt. Mus. Berlin, X, 2, p. 347 (Type *H. solox* End. = *Tabanus rhombicus* O. S.); 1925, Op. cit., XI, 2, p. 364. Stone, 1938, U. S. Dept. Agric. Misc. Pub. No. 305, p. 36 (= *Tabanus* L.). Philip, 1941, Can. Ent., LXXIII, pp. 7–8.

Hybopelma Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 351 (Type *T. quadripunctatus* F.); 1925, Op. cit., XI, 2, p. 355 (as *Hypopelma* lapsus), 409 (corrected to *Hybopelma*). Kröber, 1931, Zool. Anz., XCIV, p. 69.

Dasyphyrta Enderlein, 1922, Mitt. Mus. Berlin, X, 2, p. 351 (Type *T. maculipennis* Macq. = *T. quadripunctatus* var. *amabilis* Wlk.); 1925, Op. cit., XI, 2, p. 393. Kröber, 1932, Rev. Ent., II, p. 299.

Therioplectes Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., II, Pt. 4, No. 4, p. 425. Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 357 (in part). (Not *Therioplectes* Zeller 1842).

Sziladynus Enderlein, 1925, Zool. Anz., LXII, p. 287 (nom. nov. for *Therioplectes* End. and authors, nec. Zeller. Type *T. aterrimus* Meig.). Kröber, 1932, Rev. Ent., II, 2, p. 201. Bequaert, 1930, Harvard African Exp., p. 904. Borgmeier, 1933, Rev. Ent., III, p. 302. Kröber, 1934, Rev. Ent. IV, 3, p. 291 (? in part).

Poecilosoma Lutz, 1909, Inst. Oswaldo Cruz em Manguinhos, p. 29 (with *P. punctipenne* Macq., *P. quadripunctatum* Macq., *P. histrio* Wied., and *P. cinereum* Wied.); 1913, Brazil Medico, No. 45, p. 6, reprint (in key, no species); 1914, Mem. Inst. Osw. Cruz, VI, 3, p. 167 (reprinting of 1913 paper); 1914, Mem. Inst. Osw. Cruz, VI, 2, p. 72 (in list, with *quadripunctatum* Fab. and *punctipenne* Macq.). Bequaert, 1924, Psyche, XXXI, 1, p. 30, (Type *Tabanus quadripunctatus* Fab. 1805). Enderlein, 1925, Mitt. Mus. Berlin, XI, 2, p. 404 (= *Atylotus* O. S.). Not *Poecilosoma* Hubner 1816.

Poeciloderas Lutz, 1921, Bol. Inst. Osw. Cruz, I, p. 15. (with *quadripunctatus* (Lutz) but without indication of author or synonymy). Borgmeier, 1933, Rev. Ent., III, p. 299. (Type, *T. quadripunctatus* Fab.). Kröber, 1934, Rev. Ent., IV, 3, p. 297 (Subgenus of *Tabanus* with 10 Neotropical species).

Poecilochlamys Lutz, 1922, Zoologia Medica, Publ. Sep. da Folha Medica, Rio de Janeiro, pp. 9 and 11 (with a brief diagnosis, and in Key. No species); 1928, Est. Zool. Parasit. Venezolanas, p. 57 (in list with *P. quadripunctatus* Fab.).

Only one species of the present group occurs in Panama, the widespread *T. quadripunctatus* Fab. Philip (l. c.) has discussed the proper name for this group at some length, and his selection of *Hybomitra* End. seems to be the best way out of the tangle. While Philip treats the group as a full genus, there seem to me to be too many intergrading forms, and I prefer to consider it merely a subgenus. Kröber (1929, 1931) has described a number of forms from Central and South America, but I have seen specimens of none of them.

Tabanus (Hybomitra) quadripunctatus Fabricius

(Fig. 8)

Tabanus quadripunctatus Fabricius, 1805, Syst. Antliat., p. 99 (no sex; South America). Wiedemann, 1821, Dipt. Exot., I, p. 77 (♀); 1828, Aussereurop. Zweifl. Ins. I, p. 151 (♀; Brazil). Walker, 1854, List Dipt. Brit. Mus. V., Suppl. 1, p. 219. Schiner, 1868, Reise Novara, Zool., II, Abt. 1, vol. B, Dipt. p. 86 (♂; ♀). Osten Sacken, 1878, Cat. North Amer. Dipt., p. 57. Williston, 1895, Kansas Univ. Quart., III, pt. 3, p. 195 (Rio de Janeiro); 1901, Biol. Centr.-Amer., Dipt., I, Suppl. pp. 257 and 259 (Mexico). Kertész, 1900, Cat. Taban., p. 67. Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 143. Aldrich, 1905, Cat. North American Dipt.. p. 207. Ad. Lutz, 1907, Centralbl. Bakt. Parasit., Abt. 1, Orig., XLIV, p. 140. Kertész, 1908, Cat. Dipt., III, p. 272. Ad. Lutz and Neiva, 1909, Mem. Inst. Osw. Cruz, I, pp. 30 and 32 (States of Espirito Santo and Rio de Janeiro, Brazil). Hine, 1917, Trans. Amer. Ent. Soc., XLIII, p. 294 (♂; ♀; Costa Rica; Guatemala; Brazil, British Guiana). Surcouf, 1921, Gen. Insect., Taban., p. 81.

Tabanus (*Therioplectes*) *quodripunctatus* Osten Sacken, 1886, Biol. Centr.-Amer., Dipt., I, p. 48 (♂; ♀; Guatemala; Costa Rica).

Therioplectes quadripunctatus Speiser, 1904, Insekten-Börse, XXI, p. 148.

Poecilosoma quadripunctatum Lutz, 1909, Inst. Osw. Cruz em Manguinhos, p. 29. Ad. Lutz and Neiva, 1914, Mem. Inst. Osw. Cruz, VI, p. 72. Neiva and Penna, 1916, Mem. Inst. Osw. Cruz, VIII, p. 94. Ad. Lutz, Araujo and Fonseca, 1918, Mem. Inst. Osw. Cruz, X, pp. 167, 168 and 169 (Paraguay; Missiones, Argentina; States of Rio Grande do Sul, Sta. Catharina and Paraná, Brazil). Kröber, 1931, Zoolog. Anzeiger, XCIV, pp. 70 and 77, figs. 10–11 (♂; ♀; Costa Rica; Venezuela; Peru; Ecuador; Brazil; Bolivia; Uruguay; Mexico).

Poecilochlamys quadripunctatus Ad. Lutz, 1928, Est. Zool. Paras. Venezolanas, p. 57, Pl. IX, fig. 7 (♀; Venezuela).

Tabanus (*Poeciloderas*) *quadripunctatus* Kröber, 1934, Rev. de Entomologia, Rio de Janeiro, IV, p. 298. Galvao, 1935, Rev. Biol. Hyg. Sao Paulo, VI, pp. 121–125 (life history).

Hybopelma quadripunctatus Enderlein, 1922, Mitt. Zool. Mus. Berlin X, p. 351.

Hypopelma quadripunctatus Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, p. 355 (Missprint corrected on p. 409.).

Tabanus nigro-punctatus Bellardi, 1859, Saggio Ditter. Messicana, I, p. 67, Pl. II, fig. 8 (♀; Mexico; Cordova, Huastec).

Tabanus elegans Thunberg, 1827, Nova Acta Soc. Sci. Upsal., IX, p. 61, Pl. I, fig. 5 (no sex; no locality).

Tabanus punctipennis Macquart, 1838, Dipt. Exot.. I, pt. 2, p. 185 (♀; Goyaz, Brazil). Walker, 1854, List Dipt. Brit. Mus., V, Suppl. 1, p. 218. Kertész, 1900, Cat. Taban., p. 66. Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 143. Kertész, 1908, Cat. Dipt., III, p. 271. Ad. Lutz and Neiva, 1909, Mem. Inst. Osw. Cruz, I, pt. 1, p. 32 (States of Rio de Janeiro and Minas Geraes, Brazil). Surcouf, 1921, Gen. Insect., Taban, p. 80. Hine, 1925, Occas. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 32 (Costa Rica).

Poecilosoma punctipenne Ad. Lutz and Neiva, 1914, Mem. Inst. Osw. Cruz, VI, p. 72. Ad. Lutz, Araujo and Fonseca, 1918, Op. cit., X, pp. 168 and 169 (States of Sta. Catharina and Parana, Brazil).

Hypopelma punctipennis Enderlein, 1925, Mitt. Zool. Mus. Berlin, XI, p. 356.

Tabanus maculipennis Macquart, 1834, Hist. Nat. Ins. Dipt., I, p. 198 (♀; Brazil). Walker, 1854, List Dipt. Brit. Mus., V, Suppl. 1, p. 218. Kertész, 1900, Cat. Taban., p. 59; 1908, Cat. Dipt., III, p. 258. Ad. Lutz and Neiva, 1909, Mem. Inst. Osw. Cruz., I, pt. 1, p. 32 (State of Rio de Janeiro, Brazil). Surcouf, 1921, Gen. Insect., Taban., p. 74. Not of Wiedemann.

Bellardia maculipennis Rondani, 1863, Arch. per la Zool. Modena, III, pt. 1, p. 81.

Dasyphyrta maculipennis Enderlein, 1922, Mitt. Zool. Mus. Berlin, X, p. 344; 1925, Op. cit., XI, p. 393.
Tabanus amabilis Walker, 1848, List Dipt. Brit. Mus., I, p. 154.

There seems no reason why this species should not be placed with the North American forms with hairy eyes and vertexal tubercle. *T. reinwardtii* Wied. is in many respects the closest species though the vertexal tubercle is rather poorly developed. *T. quadripunctatus* F. shows considerable variation in this respect, however, and some specimens show a very weakly developed tubercle. The variety *amabilis* Wlk. with extensively white basal abdominal tergites, has not been so far taken in Panama.

Distribution: I have seen material from the states of Paraná, Matto Grosso, Sao Paulo, Rio de Janeiro, Bahia and Goyaz, Brasil, and from Peru, Brit. Guiana, Venezuela, Panama and Mexico. Kröber gives the range as Mexico to Uruguay.

Panama records: Summit, C. Z., Dec. 26, 1929 (Dunn); Moja Pollo, Chagres River region, Jan., May, June, July and November, 1940. The species is apparently not common in Panama.

Subgenus **Philipotabanus** subg. nov.

Phaeotabanus Kröber, 1930, Zool. Anz. LXXXVI, p. 273 (in part); 1934, Rev. Ent. IV, 3, p. 304 (in part).

This group is erected for a number of Central and South American species of *Tabanus* included by Kröber in the subgenus *Phaeotabanus* of Lutz, and corresponds in the main to Kröber's group *reticulatus* of that subgenus. *Tabanus ebrius* Osten Sacken, 1886, is selected as sub-genotype. The type of *Phaeotabanus* Lutz is *Tabanus litigiosus* Walker, 1850, selected by Bequaert (1924); and it and a number of related forms differ sufficiently from *Tabanus sens. lat.* to require full generic standing in my opinion. *P. litigiosus* Wlk., *semiflavus* Kröb. and *limpidapex* Wied. have the subepaulet bare, costa, subcosta and first vein with macrotrichia above, and the labella bear shiny chitinized plates. *Tabanus ebrius* O. S., *fascipennis* Macq., *reticulatus* Kröb., *tenuifasciatus* Kröb. and some other related forms have macrotrichia upon the subepaulet and the labella entirely fleshy.

Kröber seems to have placed a number of not very closely related forms in *Phaeotabanus*, mostly on the basis of their pictured wings and apparent lack of other distinguishing features. Thus the bare subepaulet, fleshy labella and setose fifth vein of *T. fuscipennis* Wied. set it apart, while the broad frons, curiously spotted wings and setose subepaulet of *P. multiguttatus* Kröb. and probably also *P. austeni* Kröb., which I have not seen, would place them very close to *T. venustus* O. S. from North America. I have not sufficient material to do more than point out the fact that *Phaeotabanus* Kröber is a very heterogeneous group, and to segregate the present complex, as it includes all the Panamanian species.

Philipotabanus may be defined as follows:

Small to medium sized flies, 7 to 15 mm. long. Eyes bare, unicolorous dull greenish in life. Frons narrow to very narrow; frontal callus club shaped or ridge like, vertexal tubercle absent or represented by a small bare spot. Subcallus and face normal, not bare or swollen. Antennae *Tabanus*-like, rather slender, without unusual features. Palpi rather long and very slender, proboscis not or barely equalling head height, the labella fleshy, at least half length of proboscis. Thorax, abdomen and legs brown or black, the last generally unicolorous. Wings with subepaulet bearing macrotrichia, as do the costa, subcosta, and first vein above, and the costa and subcosta beneath. All cells but the anal open; no appendix on third vein. The wings are always marked with brown, in a pattern which has a tendency to leave the areas around the cross veins hyaline, except in *fascipennis* Macq. and allied species.

The male of only one species, *ebrius*, appears to have been taken, and a description of it will be found under that species.

The species of this group are very puzzling. Either there are many rather restricted species, or a few very variable forms. I have, after considerable hesitation, decided to consider the various forms as distinct species, as I am unable to group them satisfactorily with the material at hand. Use of any single character for grouping results in a group heterogeneous for practically all other characters, i. e., there seems to be little or no correlation between the various available characters. Furthermore, there appears to be very little intermediacy, each form being rather clear cut, so that the lumping of all the forms under one species, as Hine (1925) did, only begs the question. With the accumulation of further material from a long series of localities, it may well be possible to define a few species, each with a number of local races. All the specimens I have seen are much alike in structure, differing mainly in size, intensity of body coloring, and development or reduction of the basically similar wing pattern. I have before me 6 apparently distinct forms from Panama, as well as 2 others from other localities. Of these, I have been able to assign names to 4, but not with any degree of certainty. Lacking Mexican material, I have hesitated to use either *caliginosus* Bell. or *alteripennis* Wlk. for Panama material. Kröber did not recognize any of the earlier names in this group, and redescribed *ebrius* O. S., so it is possible that some of his many names may refer to those species.

In Panama the members of the group are not uncommon during the earlier part of the rainy season in heavily forested areas. Occasionally they become annoyingly abundant, and will bite man readily, though the bite is not very painful and leaves little after effect.

The forms occurring in Panama, together with such other material as is before me, may be separated by the following key, used in conjunction with the accompanying figures.

KEY TO SPECIES OF SUBGENUS PHILIPOTABANUS

1. Whole wing black, except apex, anal cell, and median area at apices of basal cells extending to the costa (Venezuela)................**fascipennis**
   Wing otherwise marked, but areas around the cross-veins always hyaline. (See figures)...2
2. Wing pattern of dark streaks and spots. Abdomen orange brown to nearly black. Scutellum dark brown, thoracic stripes prominent. 12–14 mm..**ebrius**
   Without the above combination of characters............................3
3. Abdomen mainly yellowish or light brown...............................4
   Abdomen mainly blackish, or dark brown.................................8
4. Legs blackish. Abdomen with a small middorsal white triangle on the fourth tergite or unicolorous. Apex of wing along costa distinctly dusky. 7–9 mm...**magnificus**
   At least the last two pairs of legs yellowish or reddish. Over 10 mm..........5
5. Fore legs darker than the others. Wing pattern clear cut and distinct. Antennal tooth rather short. 11 mm. (Bolivia)................**reticulatus**
   All legs light. Wing pattern rather faded. Antennal tooth well marked......6
6. Abdomen with small white mid-dorsal triangles on tergites 2 to 4. Dark area of wing extending into base of second submarginal cell. **pterographicus**
   Abdomen without light triangles. Second submarginal cell all hyaline, rarely with a very small spot near the base...........................7
7. Small species, 11–12 mm.......................................**chrysothrix**
   Large species, 15–16 mm.......................................**elviae**
8. No dark spot at base of second submarginal cell. Third antennal segment unusually broad. Abdomen dark reddish brown. (Br. Honduras).....**kompi**
   A dark spot at base of second submarginal cell which is broadly connected with cross-band...**medius**

Tabanus (**Philipotabanus**) **ebrius** Osten Sacken

(Fig. 14)

Tabanus ebrius Osten Sacken, 1886, Biol. Centr.-Amer., Dipt. X, p. 49, Pl. I, fig. 8 (♀; Irazu, Costa Rica; Volcan de Chiriqui, Panama). Williston, 1901, Biol. Centr.-Amer. Dipt., I, Suppl., p. 259 (=*caliginosus* Bell.). Kertész, 1900, Cat. Taban., p. 48. Surcouf, 1921, Gen. Insect., Taban., p. 63. Hine, 1925, Occ. Pap. Mus. Zool. Univ. Michigan, No. 162, p. 30 (=*caliginosus* Bell.; Boquete, Panama).

Tabanus erebus Hine (nec. *T. erebus* Osten Sacken) 1917, Trans. Am. Ent. Soc., XLIII, p. 295 (confusion of *erebus* and *ebrius*).

Tabanus (*Phaeotabanus*) *ebrius* Kröber, 1930, Zool. Anz., LXXXVI, p. 277; 1934, Rev. Ent. IV, 3, p. 305.

Tabanus (*Phaeotabanus*) *ocelligerus* Kröber, 1930, Zool. Anz., LXXXVI, pp. 296–297, figs. 18, 18a (♀; Costa Rica); 1934, Rev. Ent., IV, 3, p. 305.

This species is distinguishable readily from others of the group in Panama by the distinctive wing pattern and prominently striped thorax. A male before me may be designated as Allotype.

Eyes contiguous. The large facets much larger than the small and sharply demarcated from them. The area of large facets is definitely pubescent, the small facets bare, and the former occupies about ⅔ of the total eye area. A very small tubercle is present between the eyes at vertex. Antennae missing. Palpi short, rather inflated, curved. Coloration as in the female, the thorax and abdomen with longer hairs, and the abdomen pointed.

Allotype ♂, Boquete, Chiriqui Prov. Panama, May–June, 1940 (Mrs. T. B. Monniche coll.). Certain specimens have the abdomen almost black, and I had at first considered them to be a distinct form, but more material has shown a complete intergradation of characters.

Distribution: Costa Rica and Panama, at higher elevations.

Panama records: Volcan de Chiriqui, 2000–3000 ft. (Champion; Osten Sacken's Types). Boquete, May 15, 1923 (Gaige coll., in Hine coll.), labelled "*ebrius* comp. with type." Boquete, Chiriqui Prov., May 8–9, 1939. (Many females); May–June, 1940 (Mrs. T. B. Monniche); June, 1941 (Mrs. T. B. Monniche). Cerro Punta, Chiriqui Prov., 6000 ft., Feb.–Mar., 1940 (T. T. Howard coll.).

Tabanus (Philipotabanus) magnificus Kröber

(Fig. 13)

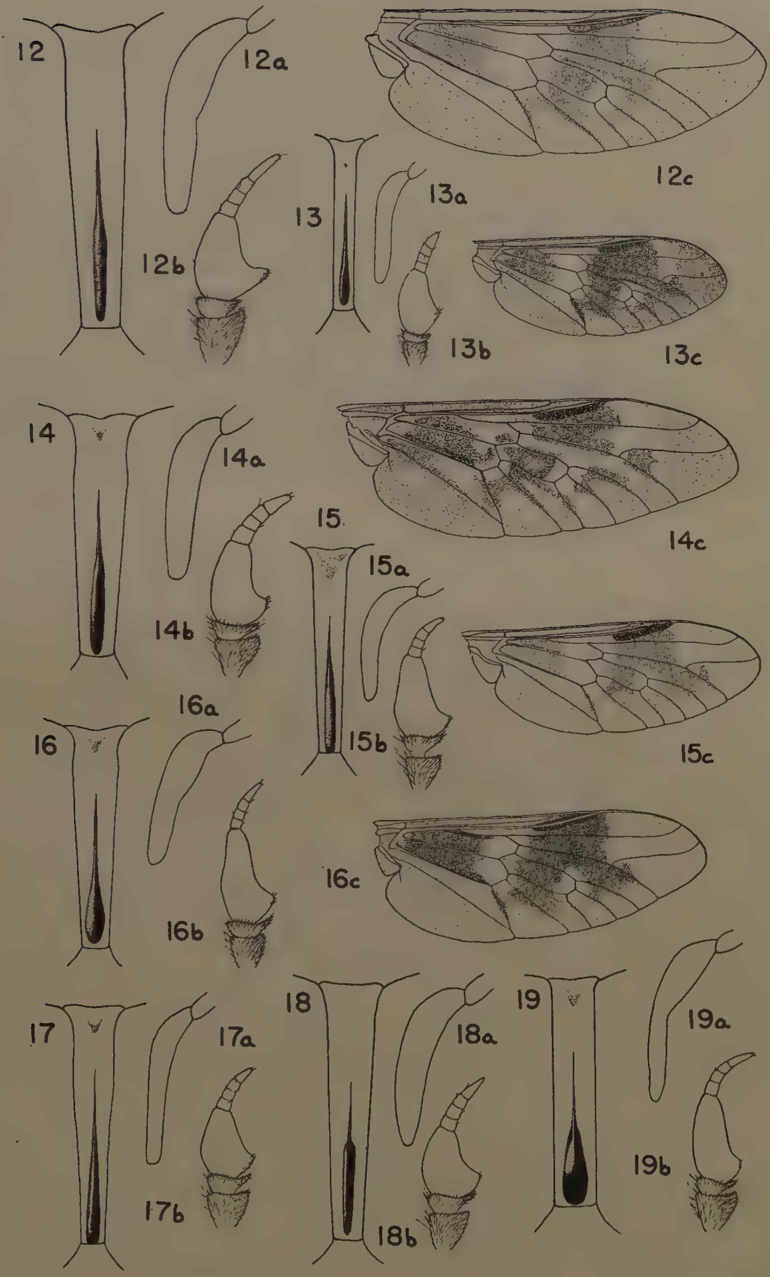
Tabanus (Phaeotabanus) formosus Kröber, 1930, Zool. Anz., LXXXVI, p. 299, figs. 21, 21a. (♀; Ecuador) (not *T. formosus* Walk. 1848). Bequaert, 1940, Rev. Ent., XI, 1-2, p. 291.

Tabanus (Phaeotabanus) magnificus Kröber, 1934, Rev. Ent., IV, 3, p. 305 (Ecuador, Costa Rica, Colombia).

This is very much the smallest species of the group in Panama, being easily mistaken at first glance for a species of *Chrysops*. It is a persistent biter in forested regions, appearing to prefer the ears and nose, like *Chrysops*. The eyes are bronzy in life, without bands.

Explanation of Figures in Plate II

Figs. 12, 12a, 12b, 12c—*T.* (*Philipotabanus*) *elviae* n. sp. Paratype. 13, 13a, 13b, 13c—*T.* (*P.*) *magnificus* Kröb. 14, 14a, 14b, 14c—*T.* (*P.*) *ebrius* O. S. 15, 15a, 15b, 15c—*T.* (*P.*) *pterographicus* n. sp. Paratype. 16, 16a, 16b, 16c—*T.* (*P.*) *medius* Kröb. 17, 17a, 17b—*T.* (*P.*) *chrysothrix* n. sp. Paratype. 18, 18a, 18b—*T.* (*P.*) *kompi* n. sp. Paratype. 19, 19a, 19b—*T.* (*P.*) *fascipennis* Macq.



Distribution: Kröber records it from Costa Rica, Colombia, Ecuador and Santo Domingo. I have seen specimens in the Hine Collection and U. S. N. M. from Higuito, Costa Rica (Schild), and Livingston, Guatemala, May 6 (Barber and Schwartz). I have also specimens from Guayaquil, Ecuador, and Surotka, C. R., May, 1924 (J. C. Bradley). As Bequaert has noted (l. c. 1940) the species probably does not occur in the West Indies.

Panama records: El Valle, Coclé Prov., May 20, 1939. New San Juan, Chagres River region, June 28, 1939. Cerro Campana, Panama Prov., July 2 and 11, 1939. Police Station, Rio Pequeni, C. Z., May 11 and Aug. 21, 1940. Cerro Azul, Panama Prov., May 17, 1941. Changuinola Dist., Bocas del Toro Prov., May 19, 1924 (F. R. Swift coll.). Boqueron River, May, 1907 (Busck coll.). Cano Saddle, Gatun, C. Z., May-June, 1923 (Shannon coll.). Mohinga Swamp, Gatun, C. Z., Aug. 26, 1940.

Tabanus (Philipotabanus) medius Kröber

(Fig. 16)

Tabanus (*Phaeotabanus*) *intermedius* Kröber, 1930, Zool. Anz., XC, p. 81 (♀; Suiza de Turrialba, Costa Rica) (not *T. intermedius* Walk., 1848; not *T. intermedius* Egger 1859.).
Tabanus (*Phaeotabanus*) *medius* Kröber, 1934, Rev. Ent., IV, 3, p. 305.

Rather extensive material from Panama before me seems to agree quite closely with Kröber's description. It differs from all the other Panama forms except certain dark specimens of *ebrius* in the nearly black abdomen, and from that species by different antennae and different wings. This species and *magnificus* Kröb. seem about equally abundant, but although both occur together in a number of localities, one is always much more abundant. Thus at El Valle and Cerro Azul both occur, but *magnificus* is dominant, while in the Chagres River region *medius* is abundant, *magnificus* rare. *Magnificus* is also abundant on the Rio Pequeni and on Cerro Campana, where *medius* has not been taken, while *medius* is common on the Cerro Macaracas and at Camp Pital, in Chiriqui, where *magnificus* has not been taken. Neither of these species seems to have been taken in the Volcan area. The other two Panama forms are known only from a few specimens, all taken in company with one or both of the above.

Panama records: Moja Pollo, Chagres River region, May 15 to Sept. 1, 1940. New San Juan, Chagres River region, June

28, 1939. Cerro Macaracas, Veraguas Prov., July 15, 1940 (E. R. and M. T. Dunn coll.). Camp Pital, Chiriqui Prov., July 11, 1929 (L. H. Dunn). El Valle, Coclé Prov., June 18, 1939. Quipo, R. P., July, 1922, (J. P. Chapin). Barro Colorado Is., C. Z., June 29, 1923 (R. C. Shannon). Cerro Azul, Panama Prov., May 17, 1941. Cabima, R. P., May 25, 1911 (Busck).

Tabanus (Philipotabanus) pterographicus sp. nov.

(Fig. 15)

Female.—Length 10 mm., of wing, 10 mm.

Eyes bare, bronzy in life. Frons narrow, about 9½ times as high as basal width, widest at vertex, pale yellowish brown. Frontal callus linear, brown, extending nearly to vertex, where there is a small, bare, slightly raised and discolored area. Subcallus, fronto-clypeus and genae pale yellowish grey pollinose, the last with sparse pale brownish hairs. Antennae as figured, orange yellow, the annulate portion darker, and with dark hairs on the first two and angle of the third segments. Palpi as figured, pale brown, black haired. Proboscis brown, the labella about ⅔ of total length, fleshy.

Mesonotum light brown, stripes nearly obsolete, dark haired; scutellum concolorous, lighter at apex, white haired. Pleura and sternum paler, sparsely brown and whitish haired. Legs yellowish brown, the fore pair darker, all black haired. Wings as figured. Abdomen dirty yellowish brown, dark haired, darker at apex, and with small but well marked triangles of white hairs on hind margins of first to fourth tergites. Venter lighter, sternites obscurely pale margined.

Holotype ♀, Moja Pollo, Chagres River region, Jan. 1, 1940. 1 ♀ Paratype, same locality, Dec. 6, 1939. To be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass.

This species may be distinguished from *reticulatus* Kröb. by the very different antennae, narrower convergent frons, and lack of apical wing infuscation. From *medius* Kröb. it differs in much lighter color, narrower frons, smaller size and reduced wing picture. The season of flight also appears to be quite different though with but two specimens this cannot be given much weight. *Pallidetinctus* Kröb., described from Panama, I have not been able to recognize in my material. It may have been based on specimens of either this or the next species, but if so, the description leaves very much to be desired.

Tabanus (Philipotabanus) chrysothrix sp. nov.

(Fig. 17)

Female.—Length 10–10.5 mm., of wing, 10 mm.

Differs from the preceding species only in the following respects. Scutellum and abdomen largely clothed with golden hairs, without contrasting tergal triangles of white hairs. Body color more rufous. Legs largely orange haired. Wing markings further reduced, lacking the extension in to the second submarginal cell.

Holotype ♀ Police Station, Rio Pequeni, Panama, May 11, 1940. 3 ♀ Paratypes, Cabima, Panama, May 19 and 21, 1911 (August Busck coll.). Holotype to be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass. Paratypes in the U. S. N. M.

This form, while agreeing with *reticulatus* Kröb. and *pterographicus* sp. nov. in size and general coloration, approaches the two following species in the wing pattern.

Tabanus (Philipotabanus) elviae sp. nov.

(Fig. 12)

Female.—Length 14–15 mm., of wing, 13 mm.

Eyes bare, probably unicolorous bronzy in life. Frons orange brown pollinose, about 8½ times basal width, wider at vertex. Frontal callus linear, not reaching base of frons. Vertex with a slightly discolored area. Subcallus, fronto-clypeus and genea concolorous, orange brown, the last with a sparse orange beard. Antennae as figured, orange throughout, the first two segments and angle of the third with reddish brown hairs. Palpi as figured, pale orange brown with black hairs.

Mesonotum orange brown, stripes obsolescent; scutellum orange with golden hairs. Pleura and sternum paler, mostly orange haired. Legs reddish, mostly golden haired, the fore pair dark haired. Wings as figured. Abdomen orange brown, reddish brown haired, the hind margins of the tergites paler and with golden hairs, forming indistinct triangles in the mid-line.

Holotype ♀ and 4 ♀ Paratypes, Buena Vista, Chiriqui Volcano, 1000 ft., Panama, March (J. D. Smith coll.). To be deposited in the M. C. Z., Harvard Univ., Cambridge, Mass.

The large size, reduced wing pattern and golden or coppery body pubescence should serve to distinguish this form. It is in many respects a large edition of *chrysothrix*, but the antennae are quite different.

Tabanus (Philipotabanus) kompi sp. nov.

(Fig. 18)

Female.—Length 11–13 mm., of wing, 10.5–12 mm.

Eyes bare, probably bronzy in life. Frons narrow, about 8 times as high as wide, yellowish grey pollinose. Frontal callus linear, chestnut brown, hardly a vestige of a vertexal bare spot. Subcallus, fronto-clypeus and genae brownish grey, the last with a sparse pale brown beard. Antennae as figured, orange, the annulate portion darker, the first two segments and angle of third dark haired. Palpi as figured, pale brown, black haired.

Mesonotum dark brown, dark haired, the stripes obsolescent. Scutellum concolorous, its posterior margin sparsely silver haired. Pleura and sternum grey and brown haired. Legs yellowish brown, the fore pair darker, all with mostly dark hair. Wings as figured. Abdomen cinnamon brown, sometimes lighter, especially on the first few tergites, dark brown to black haired. The third and fourth tergites, sometimes also the second, bear silvery haired median triangles, that on the fourth much the largest. Venter paler, sparsely pale haired, especially the light hind margins of the sternites.

Holotype ♀ and 14 ♀ Paratypes from Stann Creek, British Honduras, March 19, 1940 (W. H. W. Komp coll.); 8 ♀ Paratypes, Silk Grass, British Honduras, March 17, 1940 (Komp. coll.). Holotype and 3 Paratypes to be despoited in the M. C. Z., Harvard Univ., Cambridge, Mass., other Paratypes in the U. S. N. M. and author's collection.

I have also seen three specimens from Tela, Rep. of Honduras (Bates coll.) which I place provisionally here. The wing pattern is the same, but the frons is wider and the whole insect much paler, quite yellowish. They are much like *chrysothrix*, but the frons is broader, wing darker, the hyaline area about the end of the discal cell smaller and more circumscribed, and the antennal tooth much longer. The present species is closest to *elviae* in wing pattern, but approaches *medius* Kröber in body color.

Tabanus (Philipotabanus) reticulatus Kröber

Tabanus (*Phaeotabanus*) *reticulatus* Kröber, 1930, Zool. Anz., LXXXVI, pp. 298–299, figs. 20, 20a (♀; Peru, Pichis Weg, Pto Yessup); 1934, Rev. Ent., IV, 3, p. 305.

Two from Prov. Sara, Bolivia (Steinbach) are before me, which agree fairly well with the description. They differ from the other species here considered in the more open hyaline spot at the apex of the discal cell, short antennal tooth, and rather broader more parallel sided frons. The apical infuscation of the wing is much fainter than that shown in Kröber's figure.

Tabanus (Philipotabanus) pallidetinctus Kröber

Tabanus (*Phaeotabanus*) *pallidetinctus* Kröber, 1930, Zool. Anz., LXXXVI, pp. 297–298, figs. 19, 19a (♀; Panama); 1934, Rev. Ent., IV, 3, p. 305.

I have been unable to recognize this species in my material. The entirely dark costa is unusual, and precludes its identification with either *pterographicus* or *chrysothrix*, to which it seems most closely related. It is quite distinct from anything I have seen from the Chiriqui region.

Panama records: Chiriquicito, March (Kröber).

Tabanus (Philipotabanus) fascipennis Macquart

(Fig. 19)

Tabanus fascipennis Macquart, 1845, Dipt. Exot., Suppl. 1, p. 35, Pl. 4, fig. 1. (♀; New Grenada).

Tabanus (*Phaeotabanus*) *fascipennis* Kröber, 1930, Zool. Anz., LXXXVI, p. 278, figs. 1, 1a. (Bogota, Venezuela); 1934, Rev. Ent., IV, 3, p. 305.

A series of specimens in the U. S. N. M. from Choroni, Venezuela (Lichy) enables me to supplement Kröber's description in a few points. The frons is rather narrower, about 5½ times as high as basal width. The abdomen is wholly black, with a small white haired triangle on only the fourth tergite in my specimens. The peculiar angle of the palpi shown in Kröber's figure is present also in my material, but the antennae are a little broader than shown. The species may occur in Eastern Panama, where very little collecting has been done.

RESUME OF THE TABANIDAE OF PANAMA

In previous papers (1939–1942) the genera occurring in Panama have been discussed in some detail, and the various species figured. It remains only to give some brief notes on the Tabanid fauna of the Republic as a whole, its classification and relation to the fauna of other areas, a few remarks on the environment, and a check list of the known forms.

No work of this nature is wholly the product of its author, and though the sources of the author's ideas can be partly gleaned from the literature cited, by far the most important contributions are those resulting from conversations and correspondence with other enthusiasts. In the present case, much of whatever is useful or original in this series of papers has been the result of such discussions with Dr. Joseph Bequaert, Dr. C. B. Philip, Dr. L. L. Pechuman, Mr. R. C. Shannon and Dr. Alan Stone. To these and many others I am also indebted for the loan and gift of much valuable material, without which this study would hardly have been possible.

I have also been unusually fortunate in having been able to study a large proportion of the Central American Tabanidae available in American collections, but I have been naturally handicapped by the inaccessibility of the types of European authors. The Panama material in the following collections has been examined: U. S. National Museum; American Museum of Natural History; Museum of Comparative Zoology, Harvard University; J. S. Hine collection, Ohio State University; and the collection of Dr. Joseph Bequaert at the Harvard Medical School. In addition, the collections made by Major L. H. Dunn and preserved at the Gorgas Memorial Laboratory in Panama have been constantly available. My own field work in Panama, extending over three years, has yielded an estimated 20,000 additional specimens.

The climate and physiography of the Republic is quite diversified, but little or no detailed work on the subject appears to be available. Most of the existing temperature and rainfall records refer to the area adjacent to the Panama Canal, but are to a certain extent characteristic of the whole area. The year is divided into two seasons, "wet" and "dry." The wet season begins generally sometime in May and continues usually until the latter part of December. On the Atlantic side of the isthmus there is some rain more or less throughout the year, the "dry" season being only relatively so, but on the Pacific side, from the Canal Zone west at least to Costa Rica, there may be no rain at all from December to the end of May. East of the Canal Zone the conditions appear to be to some extent reversed, the Atlantic coast becoming progressively dryer towards the Colombian border, while the Pacific coast becomes wetter. Total annual rainfall ranges from 100, or often more, inches on the Atlantic side, to 70 inches at Panama City. Farther westward along the Pacific coast, the rainfall is probably even less.

Physically the country is encroached upon at either end by the Costa Rican and Colombian mountain systems. In Chiriqui Province the country is dominated by the Volcan de Chiriqui, an extinct volcanic peak close to 12,000 ft. high, which forms the eastern end of the chain of Costa Rican volcanoes. In Darien Province a spur of the Colombian Andes enters the country, elevations of somewhat over 8000 feet being reached. Between these two systems the country is traversed lengthwise by a sort of backbone range of hills, lowest at the Canal Zone, generally higher towards the Costa Rican and Colombian borders, but seldom exceeding 4,000 or 5,000 feet. This central ridge lies for the most part nearer the Atlantic or Caribbean coast, so that the Pacific side has a wider strip of relatively level land.

A great deal of the Republic is still covered with heavy forest, but about the Canal Zone and along the Pacific coast west of the Canal much of it has been cleared at one time or another for agriculture, and then allowed to grow up again into an utterly impenetrable second growth. True llanos, rolling grass-covered plains, are increasingly evident westward of the canal, and some of these at least are a natural feature of the country, though it seems very probable that their original area has been much increased by the annual fires which are set by the inhabitants to improve the grazing, as this area is largely a cattle section.

Swamps, both fresh and tidal, are found along both coasts, but other than the artificial Gatun and Madden Lakes, there seem to be but few large bodies of fresh water. The tidal mangrove swamps form one of the most interesting habitats, and quite a number of Tabanids seem to be wholly or largely confined to them. Altitude, here as elsewhere, has an important influence on vegetation, and the tops of even relatively low hills, 2500–3000 feet, are kept moist and green throughout the dry season by often almost constant cloud caps. The so-called fog forest developing on these hills yields very interesting collecting, and quite a number of Tabanids seem confined to these areas.

Since most Tabanids are haematophagous, Bequaert (1940, p. 264) has suggested that the paucity of large mammals in the Antilles may well be the cause of the depauperate Tabanid fauna found here. Panama, being continental, has a considerable number of large native mammals, in addition to a good population of horses and cattle. Two genera of deer, *Odocoileus* and *Mazama*, tapir, (*Tapirella bairdi*), two genera of peccary (*Pecari* and *Tayassu*), the capybara (*Hydrochoerus*), puma, jaguar and ocelot are all large enough to be attractive to Tabanids, while there are a host of smaller mammals as well as several large reptiles such as the iguana lizard, various species of freshwater and marine turtles, and large snakes. Observations of the feeding habits of Tabanids on wild animals are naturally not often made, but the capture of a specimen of *Fidena isthmiae* Fairch. feeding on a large snake (*Epicrates* or *Constrictor* sp.) by Mr. W. H. W. Komp is worthy of note. Tabanids have previously been recorded as feeding on both crocodiles and sea turtles. (Bequaert, 1940).

The relationships of the Panama Tabanid fauna to that of neighboring areas must be largely a matter of guesswork, since little intensive collecting has been done anywhere in Tropical America. My own collecting in Panama has been largely confined to the central part of the Isthmus, so that many species coming into the country from Costa Rica and Colombia have undoubtedly been missed. Nevertheless, the information available tends to show that the Central American elements in the fauna are slightly in the ascendency. Thus of the 59 Panama species known to occur in other areas also, 12 or about 20% are known from South America but not from Central America, 17 or about 30% are known from Central America but not from South America, while 30 or about 50% are known from both South and Central America. The 30 species known at present only from Panama can only tentatively be classed as true endemics, since many or most of them may be found in neighboring areas when more collecting has been done.

A comparison of the total number of species known from Panama with similar lists from other areas, indicates that the fauna is a relatively rich one. The land surface of the Republic is estimated to be between 31,500 and 33,800 square miles (Encyclopaedia Brittanica, 11th Ed.), and 89 species are known to occur within its boundaries. Bequaert (1940a) gives the following figures for the Antilles: Antilles as a whole, 95,000 sq. mi. and 42 species; Cuba, 44,000 sq. mi. and 12 species; Hispaniola, 28,250 sq. mi. and 17 species. The Republic of Honduras, which has been little explored, contains 46,000 sq. mi. and Bequaert lists (1940a) 22 species as occurring there. The same author lists (1940b) 23 species from Trinidad, with an area of only 1,734 sq. mi. In North America, where the Tabanids have been much more extensively studied and collected, Johnson lists (1925) 85 species for the 6 New England states, with an area of 64,800 sq. mi., and my own list of Florida species (1937), to which several species have been subsequently added, comprises 66 species from an area of about 59,000 sq. mi.

CLASSIFICATION: HISTORICAL

The classification of the Tabanidae, in spite of a number of attempts to place it on a sound basis, still remains in a very chaotic condition, and there seems no immediate prospect of improvement. The characters hitherto used to group the species into genera and higher categories seem for the most part quite inadequate, and a complete re-study of the whole family in a search for more and better characters will be necessary before any real progress can be made.

Three main systems of classification of the family exist. Of these the oldest divides the family into two subfamilies, *Pangoniinae* and *Tabaninae*, each of which is divided into a variable number of genera. The most recent attempt to apply this system to the world fauna is that of Surcouf in the Genera Insectorum (1921). Here the *Tabaninae* comprise 18 genera of which 9 are monotypic, while the Genus *Tabanus* with three subgenera contains 1140 species. In the *Pangoniinae*, Surcouf recognizes 42 genera, of which 16 are monotypic, while *Chrysops* and *Pangonius*, the two largest genera, are listed as containing 200 and 109 species respectively. While Surcouf recognizes a number of the groups proposed by Lutz (1909) in the *Pangoniinae*, he does not recognize Lutz' divisions of the *Tabaninae*.

The first important departure from the old system was proposed by Adolfo Lutz in a series of papers (1909 et seq.) dealing with the Brazilian fauna. He replaced the old subfamilies *Pangoniinae* and *Tabaninae* by the names *Opisthacanthae* and *Opisthanoplae*, and divided the former into the subfamilies *Pangoniinae*, *Silviinae* and *Chrysopinae*, and the latter into the subfamilies *Tabaninae*, *Lepiselaginae* and *Diachlorinae*. The *Tabaninae* was further divided into two series on the basis of the presence or absence of a long tooth on the third antennal segment, the *Schistocerae* having a long tooth, the *Haplocerae* lacking it. The two series were then divided into genera largely on the basis of eye coloration, the *Schistocerae* containing 9 genera, of which 6 were new, and the *Haplocerae* consisting of 9 roughly parallel genera, of which 8 were new. Lutz' system had a number of features to recommend it, and many of his groups seem to express natural relations, but the system was founded on a rich but limited fauna, while Lutz was often unfortunate in his choice of distinguishing characters. Many of his names were first published in lists of species, while others appeared in keys without species, and in no case were genotypes specifically selected. This led to considerable confusion and misunderstanding and the loss of several of Lutz' names.

In 1922 and 1925 G. Enderlein published what was intended to be a world-wide revision of the family. Following Lutz in the use of *Opisthacanthae* and *Opisthanoplae* Enderlein goes much further, dividing the family into 10 subfamilies, 19 tribes, and 170 genera. His classification is rather arbitrary, in many cases separating quite closely allied forms. Very few new characters are used, dependence being placed mainly on the various possible groupings of already known characters. The system has been widely criticized (Bequaert 1924, Kröber, 1932, Stone, 1938); but Enderlein has selected genotypes throughout, so that in many cases his groups are recognizable. He was, however, not always careful, and in a number of cases genotypes had previously been selected by others. A number of his supposedly new species, upon which he based new genera, have also proven to be synonyms; and in other cases his genotypes and genera were based on misdetermined material. In one case at least, he placed the same species in three different genera. Enderlein recognized only a few of Lutz' genera, sinking the majority of them more or less at random.

Beginning about 1925, Otto Kröber published a long series of papers dealing exhaustively with the family, the Neotropical fauna alone occupying about 40 titles. In two papers (1932 and 1934) his system of classification, as far as the Neotropical region is concerned, is set forth. For the most part he follows Enderlein with minor changes, recognizing many of Lutz' generic names. He used 83 generic and subgeneric names for the Neotropical fauna. While Kröber's work is a great improvement over that of Enderlein and Lutz, he also has failed to discover any new characters which can be used for classification, and his system remains very largely artificial.

Dr. J. Bequaert (1930) in discussing the African *Tabanidae* recognizes 3 subfamilies, the *Coenomyinae*, *Pangoniinae* and *Tabaninae*, and divides the second of these into 3 tribes, the *Pangoniini*, *Chrysopini* and *Scepsidini*, and the *Tabaninae* into the *Tabanini* and *Haematopotini*. This treatment is strongly contrasted with that of Enderlein and Kröber, and has all the advantages of great simplicity. I feel, however, that the very diverse elements to be found, especially in the *Pangoniini* and *Tabanini* of Bequaert are susceptible of more detailed analysis. I realize, however, the danger, especially when dealing with a limited fauna, of too fine a division, and feel that in dealing with the Panama species a middle course is advisable.

Dr. C. B. Philip has recently published (1941) a very stimulating scheme of classification of the Nearctic *Tabanidae*, with most of which I find myself in hearty agreement. He divides the Nearctic forms into 3 subfamilies, 9 tribes, and 29 genera. Of these, 2 subfamilies, 8 tribes, and 11 genera also occur in Panama. Philip separates the genus *Diachlorus* from *Stenotabanus*, placing them in separate tribes; but I believe this to be unnecessary, and include both in the *Diachlorini*. I also believe *Chlorotabanus* to be rather closely related to the other *Dichelacerini* through such forms as *Cryptotylus*, and not worthy of tribal treatment.

Failing any entirely satisfactory existing system, it has been found quite impossible to come to any final decision as to the correct placement of a number of the Panama forms. While I have had the opportunity of examining a great deal of Neotropical material, as well as a large majority of the described Neartic species, and a fair number of Old World forms, still I am very far from being in a position to erect any comprehensive scheme of classification for the whole family. The arrangement here adopted for the Panama species is therefore entirely tentative, and the key to supra-specific categories will probably not hold for extra-limital forms. I have used in the key a number of characters hitherto very seldom noticed in the family, but which seem to me in many cases to indicate relationships much better than most of the characters previously employed.

CLASSIFICATION OF THE SPECIES OCCURRING IN PANAMA

I have reverted to the terms *Pangoniinae* and *Tabaninae* for the main divisions of the family as it is represented in Panama, as the numerous subfamilies of Enderlein and Kröber do not seem to me sufficiently definable, nor do they appear to be at all of equal rank. In the *Pangoniinae* I recognize only two tribes as occurring in Panama, the *Chrysopini*, corresponding to the subfamily *Silviinae* of Kröber's catalogue (1934) and the *Pangoniini*, which includes all three tribes of the *Pangoniinae* of Kröber's catalogue. Among the *Tabaninae*, I recognize 5 tribes as follows: the *Lepiselagini*, corresponding to Kröber's subfamily of the same name; the *Diachlorini*, corresponding in part to Kröber's *Diachlorinae* and *Stenotabaninae;* the *Bolbodimyini* of Philip; the *Dichelacerini*, which includes part of Kröber's *Psalidini* and most of his *Dichelacerini* plus *Chlorotabanus* of his *Tabanini;* and the *Tabanini*, which includes part of Kröber's *Bellardiini*, *Dichelacerini* and *Tabanini*. I give below a key to the tribes and a key to the genera occurring in Panama, with the reservation that they will not always work in dealing with extra-limital forms.

KEY TO TRIBES

1. Hind tibiae with apical spurs. Subcosta always bare both above and below. Labella always with shiny sclerotized plates......2. **Pangoniinae**
Hind tibiae without apical spurs. Subcosta generally hairy, at least with some hairs beneath...3. **Tabaninae**

2. First two antennal segments often together as long or longer than third. Third antennal segment of a long basal part and 4 terminal annuli. Proboscis seldom exceeding headheight....................**Chrysopini**
First two antennal segments seldom together equalling half the length of the third. Third antennal segment of 7 or 8 distinct subequal annuli. Proboscis often much exceeding head height..................**Pangoniini**

3. Subepaulet bare, rarely with a few scattered bristles......................4
Subepaulet clothed with macrotrichia like those on the costa........**Tabanini**

4. Third antennal segment with a long dorsal tooth or spine, or the labella shiny and sclerotized and the whole insect greenish in life....**Dichelacerini**
Third antennal segment never with a long dorsal spine, generally weakly angulate or subcylindrical, or labella wholly membranous................5

5. Palpi shiny, flattened, the outer surface convex, the inner concave, those of the male nearly as large as in female, greatly inflated. All tibiae inflated. Wings black on basal half to two-thirds, hyaline apically. Largely black and shiny species with shiny facial callosities. Labella wholly membranous.......................................**Lepiselagini**
Palpi pollinose, slender or inflated, but not flattened, those of the male small...6

6. Subcallus and first antennal segment greatly inflated, shiny; face normal, pollinose. Body and wings largely black. Labella with small shiny plates at base. Palpi slender, pollinose. Upper branch of third vein turned abruptly forward..............................**Bolbodimyini**
Subcallus and first antennal segment not inflated. Upper branch of third vein normal. Wings never predominantly black.......**Diachlorini**

KEY TO GENERA

1. Hind tibiae with apical spurs. Subepaulet without macrotrichia, subcosta bare both above and below. Labella always with shiny sclerotized plates, 2. **(Pangoniinae)**
Hind tibiae without apical spurs. Subepaulet, wing veins and labella variable...6. **(Tabaninae)**

2. Third antennal segment of an often ringed but consolidated basal part and four terminal annuli. Proboscis short, seldom much exceeding head height. Mostly small species of less than 12 mm. length and with mottled wings...**Chrysops**
Third antennal segment of 7 or 8 distinct annuli; the first two segments never equalling ½ the length of the third. Proboscis often elongate. Larger species mostly over 12 mm.

3. Eyes bare. Face not produced and snout-like, proboscis not longer than hind tibia, generally much shorter. First posterior cell closed; fork of third vein generally with an appendix.......................**Esenbeckia**
Eyes pilose. Face more or less produced and snoutlike. Proboscis longer than hind tibia, often as long as whole insect, more or less extensile, the basal portion coiled within the head capsule..........................4

4. Third antennal segment of seven annuli, bipectinate, the first six annuli bearing long dorsal and ventral finger like processes. Brown insects with the first posterior cell of the wing closed and long petiolate. .**Pityocera**
Third antennal segment without such finger-like processes.................5

5. First and fourth posterior cells closed and petiolate. Wings often with dark markings...**Scione**
First posterior cell closed or narrowly open, fourth always open. Wings hyaline or smoky, never with prominent dark markings.............**Fidena**

6. Subepaulet without macrotrichia, or the macrotrichia much less dense than on the costa, generally thin and scale-like. Third antennal segment often with a prominent dorsal tooth or long spine. Labella often with shiny sclerotized plates...7

Subepaulet with macrotrichia similar to those on the costa, often inflated. Dorsal tooth of third antennal segment usually short, rarely reaching beyond first annulus. Labella fleshy, without shiny sclerotized plates. . . . 16

7. Basal part of third antennal segment with a strong dorsal angle or minute tooth. 8

Basal part of third antennal segment with a strong dorsal tooth or long slender spine. 12

8. Labella short, with shiny sclerotized plates. Vertexal tubercle and frontal calli absent in female, the first present in the male. Eyes brownish in life, without irridescent markings. Whole insect green or greenish in life. . . . . **Chlorotabanus**

(If frontal callus present, see (*Cryptotylus*).

At least basal frontal callus present. Eyes almost always with irridescent green or purple markings. 9

9. Labella with at least small shiny plates at base. Largely black insects with wings partly or largely black. Facial area and palpi swollen, and shiny, or first antennal segment greatly inflated. 10

Labella wholly membranous. Tibiae normal, or only the fore pair inflated. Palpi and first antennal segment never as above. 11

10. Palpi very broad and flattened, the integument shiny. First antennal segment normal. Thorax and abdomen with bright green metallic scales, **Lepiselaga**

Palpi very slender, pollinose. First antennal segment greatly inflated. Upper branch of third vein turned abruptly forward, joining the costa closer to the second vein than to the wing apex. No green metallic scales. . . . . **Bolbodimyia**

11. First antennal segment more or less elongate, usually not less than ⅛ the length of the third segment. Basal part of third segment usually obscurely annulate, sometimes with a blunt dorsal angle. Frontoclypeus usually shiny. Mesopleura pearly pollinose. Subcosta bare above, fifth vein spinose above. . . . . **Diachlorus**

First antennal segment short, less than ¼ length of third segment. Frontoclypeus rarely shiny. Mesopleura not pearly pollinose. Subcosta and fifth vein variable. (See also couplet 13). . . . . **Stenotabanus**

12. Third antennal segment with a strong angle or moderately long dorsal tooth which does not reach the first annulus. 13

Third antennal segment with a long slender forward pointing spine, which reaches at least to the first terminal annulus. 14

13. No vertexal tubercle in either sex. Labella with shiny plates. Whole insect greenish in life, unicolorous. . . . . **Cryptotylus**

Vertexal tubercle present, at least in female. Labella without shiny plates, though sometimes small and compact. Whole insect not greenish, generally with contrasting markings. . . . . **Stenotabanus**

14. Eyes pilose under a hand lens. Labella small and compact, though not showing shiny plates. . . . . **Dicladocera**

Eyes bare under a hand lens. Labella showing shiny sclerotized plates. 15

15. Stout, often hairy species; at least the fore tibiae more or less inflated and the hind tibiae with a fringe of long hairs. Antennae rather short and stubby. Palpi inflated. . . . . **Stibasoma**

Usually slender species. Tibiae neither inflated nor fringed. Antennae moderate to very long. Palpi slender to almost thread-like. . **Dichelacera**

16. All tibiae greatly inflated. Palpi inflated and shiny. Basal portion of third antennal segment nearly 4 times as long as annulate portion. Whole insect shining blue black, only mesonotum greyish pollinose. Subepaulet with sparse macrotrichia in female, none in male. . . . . **Selasoma**

Tibiae and palpi normal. Basal portion of third antennal segment seldom if ever twice as long as annulate portion. 17

17. At least 3 small but well marked ocelli present. Eyes bare, unicolorous in life. Scutellum and mesonotum with white or yellow hairs, abdomen black or brown, with various white markings. . . . . **Leucotabanus**

Without ocelli, with or without a vertexal tubercle. Eyes bare or pilose in one or both sexes. . . . . **Tabanus**

CHECK LIST OF THE TABANIDAE OF PANAMA

- Subfamily Pangoniinae
  - Tribe Chrysopini
    - *Chrysops alleni* Fairch.
      - *calogastra* Schin.
      - *chiriquensis* Fairch.
      - *incisa Macq.*
      - *melaena* Hine
      - *mexicana* Kröb.
      - *soror* Kröb.
      - *variegata* (de Geer).
  - Tribe Pangoniini
    - *Esenbeckia chagresensis* Fairch.
      - *illota osornoi* Fairch.
      - *prasiniventris* (Macq.)
      - *translucens* (Macq.)
    - *Fidena fulvosericea* Kröb.
      - *gracilis* Kröb.
      - *howardi* Fairch.
      - *isthmiae* Fairch.
      - *pyrausta* (O. S.)
    - *Pityocera festae* Gig.-Tos.
    - *Scione aureopygia* Fairch.
      - *claripennis* Ricardo.
      - *maculipennis* (Schiner).

- Subfamily Tabaninae
  - Tribe Dichelacerini
    - Dichelacera
      - (*Dichelacera*) *analis* Hine
        - *marginata* Macq.
        - *regina* Fairch.
      - (*Psalidia*) *fulminea* (Hine)
      - (*Catachlorops*) *transposita* (Walk.)
    - *Dicladocera badia* Kröb.
    - *Stibasoma apicimacula* Fairch.
      - *chionostigma* (O. S.)
      - *fulvohirtum* (Wied.)
      - *theotaenia panamensis* Curran
      - *venenata* (O. S.)
    - *Cryptotylus limonus* (Towns.)
      - *luteoflavus* (Bell.)
      - *unicolor* (Wied.)
    - *Chlorotabanus inanis* (Fab.)
      - *mexicanus* (Linn.)
  - Tribe Lepiselagini
    - *Lepiselaga crassipes* (Wied.)
    - *Selasoma tibiale* (Fab.)
  - Tribe Bolbodimyini
    - *Bolbodimyia erythrocephala* (Bigot)
  - Tribe Diachlorini
    - *Diachlorus curvipes* (Fab.)
      - *jobbinsi* Fairch.
    - Stenotabanus
      - (*Stenotabanus*) *calvitius* Fairch.
        - *constabulorum* Fairch.
        - *fulvistriatus* (Hine)
        - *jaculator* Fairch.
        - *lerida* Fairch.
        - *maculifrons* (Hine)
        - *minusculus* (Kröb)
        - *pequeniensis* Fairch.
        - *plenus* (Hine)
      - (*Aegialomyia*) *changuinolae* Fairch.
        - *paitillensis* Fairch.
      - (*Brachytabanus*) *longipennis* Kröb.
  - Tribe Tabanini
    - *Leucotabanus canithorax* Fairch.
      - *flavinotum* (Kröb.)
      - *leucaspis* (Wied.)
    - Tabanus
      - (*Tabanus*) *bigoti* Bell.
        - *erebus* (O. S.)
        - *ferrifer* Walk.
        - *globulicallosus* Kröb.
        - *importunus* Wied.
        - *nereus* Fairch.
        - *praepilatus* Fairch.
        - *rhizophorae* Fairch.
        - *rixator* Fairch.
        - *umbraticolus* Fairch.
      - (*Bellardia*) *albocirculus* Hine
        - *de-filippii* Bell.
        - *piraticus* Fairch.
        - *pseudoculus* Fairch.
        - *oculus* Walk.
      - (*Hybomitra*) *quadripunctatus* Fab.
      - (*Neotabanus*) *angustivitta* Kröb.
        - *amplifrons* Kröb.
        - *dunni* Fairch.
        - *enanus* Fairch.
        - *fumatipennis* Kröb.
        - *lineola* var *carneus* Bell.
          - var *plangens* Walk.
          - var *stenocephalus* Hine
        - *maya* Beq.
        - *unistriatus* Hine
        - *vittiger* var *guatemalanus* Hine
      - (*Philipotabanus*) *chrysothrix* Fairch.
        - *ebrius* O. S.
        - *elviae* Fairch.
        - *magnificus* Kröb.
        - *medius* Kröb.
        - *pallidetinctus* Kröb.
        - *pterographicus* Fairch.

ADDENDA

Since the publication of some of the earlier papers in this series, certain information has come to hand which necessitates a few changes and additions. In the paper on *Dichelacera* and related genera (1940), further study of more material has convinced me that *Psalidia* End. and *Catachlorops* Lutz had best be considered merely as subgenera of *Dichelacera* Macq. As suggested in that paper (p. 693) *Tabanus fulmineus* Hine 1920 is nothing but a dark form of *ocellata* End. 1925 in which the subapical hyaline areas in the wing are almost obsolete, hence the species takes Hine's name. I have examined Hine's types in Columbus, Ohio. *Bellardia furcata* Bigot 1892 is an additional possible synonym for the species. On p. 689 of the same paper *Tabanus umbratus* Hine was suggested as a possible earlier name for *Dicladocera badia* Kröber. I have since seen Hine's type, and it is a quite distinct species of *Catachlorops*. Three additional females of *D. badia* have since been taken (El Valle, Coclé Prov., R. P.), and the wings are somewhat more strongly marked than shown in my figure, which was drawn from a long preserved specimen.

I have also seen specimens of *Tabanus venenatus* O. S. (1 ♀, El Volcan, Chiriqui, R. P., F. E. Lutz coll., and 1 ♂; 1 ♀, near Caracas, Venezuela). It appears to be best placed in the genus *Stibasoma* where it forms a member of a group including *T. planiventris* Wied and *T. viridiventris* Macq. These species are placed by Kröber in *Amphichlorops* Lutz, but the genotype of that genus, *T. flavus* Macq., appears to be much more closely related to *Catachlorops* than it does to the present group. If further study should indicate the desirability of separating this small group of greenish insects from *Stibasoma*, the name *Rhabdotylus* Lutz, with *T. planiventris* Wied. as type is available.

Additional locality records which extend the ranges of two species have also come to hand. *Dichelacera analis* Hine is represented by a female from Rio Curitingua, Nicaragua (Ivan Sanderson coll.), and *T.* (*Neotabanus*) *dunni* Fairch. by a female from the Pacific coast of the same country (W. H. W. Komp coll.).

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BOOK NOTICES

INFORME SOBRE "TUCURAS," by RAFAEL SCHIUMA. 120 pages, 4 colored plates and many text cuts. 1938. Published as Publicacion Miscelanea No. 43 de la Direccion de Sanidad Vegetal, MINISTERIO DE AGRICULTURA, REPUBLICA ARGENTINA. Paper bound.

This volume is a popular handbook on one of the grasshopper pests of Argentina, *Trigonophymus arrogams* Stål. In nine chapters it covers the destructive habits of the pest, its enemies and environmental difficulties, experiments with various poisons and cultural methods of control, and finally outlines a "Plan de accion."—C. H. K.

MOSQUITOES OF THE ETHIOPIAN REGION III. Culicine Adults and Pupae, by F. W. EDWARDS. Pages viii and 499, 4 colored plates, 184 text figs. 7 x 10 inches, cloth. 1941. Published by the BRITISH MUSEUM (Natural History), Cromwell Road, London, S. W. 7, and by BERNARD QUARITCH, LTD., DULAU & CO., LTD., and THE OXFORD UNIVERSITY PRESS.

Edwards died November 15, 1940, it is said from an injury received in a German bombing raid on London. The manuscript for the Mosquitoes of the Ethiopian Region was completed before the author's death. The numerous figures of male genitalia are by his own hand.

Part I of the present volume, pp. 1–353, deals with the Taxonomy of Culicine Adults. Part II, pp. 354–428, covers the Taxonomy of Culicine Pupae. Part III brings up to date (Corregenda and Addenda) the matter dealt with in Volumes I and II of the present work, while Part IV is a discussion of Zoogeography and Ethiopian Mosquitoes.

Edwards was a comparatively young man and, as the specialist on Diptera in the British Museum, had already established a reputation for a great amount of basic work in the taxonomy of that order. His future was bright for many years of just such work. Then suddenly he became a casualty of the war. This magnificent three volume work on African mosquitoes will remind his admirers for many years to come of what he could have accomplished had he lived.—C. H. K.

MEMORIA DE LA COMISION CENTRAL DE INVESTIGACIONES SOBRE LA LANGOSTA, 1934 (publ., 1936), 250 pp., 35 plates and many maps, charts, etc.; 1935 (publ., 1937), 126 pp., 10 plates, maps, etc.; 1936 (publ., 1939), 300 pp., 22 plates (5 colored), maps, etc. Published by the DIVISION DE ZOOLOGIA AGRICOLA, MINISTERIO DE AGRICULTURA, BUENOS AIRES, REPUBLICA ARGENTINA. Cartridge-paper bound.

The three volumes on grasshopper control in northern Argentina reached the Annals office this summer. They are at once an exposition (1) of the enormous size of the problem which covers much of the vast area west and northwest of Buenos Aires, (2) of the thorough mapping and ecological study of the affected area and (3) of the very extensive development of applied entomology in Argentina. In this office we have been prone to judge the level of the development of entomology in any country by the number of subscriptions in that area. The Annals has little South American entomology to offer subscribers "down under," hence the short South American subscription list. Argentina and Brazil have many well developed centers of applied entomology whose staffs of well trained scientists see problems in their broad aspects and who are doing yeoman service in the mastery of insect pests. The three large well printed and beautifully illustrated volumes on the locust problem in Argentina are very worth while exhibits to that effect.—C. H. K.

A PRELIMINARY REVISION OF HESPERIA, by Arthur Ward Lindsey. Published as pages 1–50 and six plates of Vol. XXXVII, Denison University Bulletin, Journal of the Scientific Laboratories, April, 1942.

The Assistant Managing Editor of these Annals has studied hesperoid butterflies for many years. Revisional work began in earnest the years he was Curator of the William Barnes Collection of North American Lepidoptera at Decatur, Illinois. It was continued when he became, first, head of the Zoology Department and just recently head of the Biology Department (Zoology and Botany) at Denison University. Professor's Lindsey's catalogue and revisional lists and other papers on hesperids are basic works which are widely used in butterfly collections the world over.

The revision covers twenty-eight species, the majority of which are American. Lindsey's personal collection contains every known species but he has also checked the collections in the various American museums and important collections abroad. The illustrations consist of two plates of male genitalia and four plates in gray and white of color patterns. Great care was taken to obtain sharp photographs.
—C. H. K.

INSECTS OF GUAM, I. Edited by O. H. Swezey. 1942. Pages v and 218; 13 text figs. and 10 pls. 7 x 10¼ inches. Published by the Bernice P. Bishop Museum, as Bull. 172, Honolulu, Hawaii. Also mailed out by the Department of Entomology, Experiment Station, Hawaiian Sugar Planters' Association.

This is one of two proposed volumes on the insects of Guam. In 1936 the Sugar Planters' Association furnished funds for a collecting expedition to Guam to collect and list local insects which if introduced into Hawaii might become serious crop pests. The Bernice P. Bishop Museum helped with identifications and publication as it has been generally interested over a period of years in the insects of Polynesia. The present volume covers the Odonata, Thysanoptera, Homoptera, Neuroptera, Lepidoptera (in part), Coleoptera (in part), Strepsiptera, Hymenoptera (in part) and the Diptera (in part). Each group has been worked up by a recognized specialist. We see such names as O. H. Swezey, Dudley Moulton, E. C. Zimmerman, T. D. A. Cockerell, Charles P. Alexander and J. R. Malloch. With the completion of the study of insect distribution over the islands of the vast Pacific Ocean we will have a better idea of the geological evolution of this maze of islands particularly during the Tertiary and recent times.—C. H. K.

INDEX VI TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY, January 1, 1935, to December 31, 1939. Compiled by Mabel Colcord, edited by E. Porter Felt and Stanley W. Bromley. 1942. Pages 12 and 1–815, 6¼ x 9⅜ inches, black cloth bound. Published by The American Association of Economic Entomologists, (address) E. N. Cory, Secretary, College Park, Md. Price $6.00.

This necessity in American applied entomology is now in its sixth volume as the "Colcord Index." It is in the usual standard form, a straight alphabetical list of noxious and beneficial insects, insecticides and other items in the literature of economic entomology with proper cross references.

Miss Mabel Colcord, Librarian of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, deserves some real thanks from the students of applied entomology the world over for the extent of work in the six great catalogues that have appeared under her supervision, probably much of the work by her own hand. Her untiring work has kept the research of many men fairly well up to date.—C. H. K.

THE CRANE FLIES (TIPULIDAE) OF THE GEORGE RESERVE, MICHIGAN, by J. Speed Rogers. Misc. Publ. Mus. Zool., University of Michigan, No. 53 (1942), pp. 1–128, 1 map, 2 tables, 8 pls., 6¾ x 10 inches, paper bound.

This ecological work is based on over 30,000 adult specimens and 1,000 larvae and pupae collected during intensive field studies in the summers of 1936, 1937 and 1938, and in the spring of 1937. The work attempts to determine what species comprise the fauna, and to ascertain their relative abundance, habitat correlations and seasonal distribution.

Pages 1–57 cover the general ecology; pages 58–120 is a list of 206 species, which gives more specific items of life history and ecological relationships, while pages 121–128 give additional notes on study in 1941.

The plates are excellent photographs of the varied habitats found on the George Reserve.—C. H. K.

CATALOGUE OF BACTERIA ASSOCIATED EXTRACELLULARLY WITH INSECTS AND TICKS, by Edward A. Steinhaus. 1942. Pages iii and 206, 5½x8½ ins., photolith printed, cartridge board bound. Published by Burgess Publishing Co., 426 South Sixth St., Minneapolis, Minn. Price $2.00.

The author states in his Introduction: "A Survey of the literature on bacteriologic-entomologic relationships indicates that there is an utter lack of conformity between the names given to certain bacteria by bacteriologists and those used by entomologists for the same bacterium. Entomologic literature is filled with names given to bacteria, references to which are not found anywhere in bacteriologic literature. Furthermore, there are numerous examples of the same bacterium being cited with different names by different authors. To add to the confusion, many investigators have not attempted to identify or to classify properly the bacteria they have isolated or found associated with insects. This has resulted in many taxonomic 'ghosts' and ambiguities". This editor can confirm the author's statement as at times articles on insect diseases offered to these Annals have been returned because no positive attempt has been made to identify the recognized causitive organism by methods standard to research in the taxonomy of bacteriology. Such an unfinished condition of an article would leave librarians, bibliographers and other cataloguers and students unable to properly classify the article as to the causitive organism of the disease. In that far the piece of literature would be another "lost" article in the general literature on diseases of insects. Entomological literature has become too extensive and complex to have to deal with articles that are "floaters." This confused condition of the literature on the diseases of insects has already been protested in this journal (DeBach and McOmie, Ann. Ent. Soc. Amer. 32, p. 145, 1939).

Pages 4–25 give a general discussion of the subject; 25–31 a bibliography of general papers; page 32 a plan and method of using the catalogue; pages 33–186 contain the catalogue with species amply referenced into entomological literature; pages 187–191 an index of authors with 192–206 a subject index.

Steinhaus has been located in outstanding staffs of bacteriologists containing men of broad interests where this type of listing has had every chance of being well done, where the help of both bacteriologists and entomologists could be had. At present he is at the U. S. Public Health Service Rocky Mountain Laboratory, Hamilton, Montana. The work was initiated at Ohio State University under Professor Alva Peterson and the University's staff in Bacteriology.—C. H. K.

CORRECTIONS (ERRORS AND OMISSIONS) ✓

Corrections are limited to critical omissions and serious errors.—The Editors.

Sabrosky, Curtis W. 1941. An annotated list of genotypes of the Chloropidae of the world (Diptera). Annals, 34(4): 735–765, December.

The following important errors and omissions have been noted:

p. 738, footnote 3—An additional important item of internal evidence has been discovered in a brief discussion by Loew at the end of his tenth Centuria (1872, Berl. Ent. Ztschr., XVI, p. 113), where he mentions that he had divided the genus *Chlorops* into subgenera in the "Zeitschrift für Entomologie, 1866." While it might be claimed that he merely quoted the title page of the volume, it seems more probable that he would have dated his own genera from 1861 had it actually been the case.

p. 741, line 6—generic name should read CONIOCHLOROPS.

p. 741, line 16 from bottom—heneric name should read CRYPTONEVRA.

Both of these are entirely unintentional emendations, due to overlooked typographical errors.

p. 749—*Cadrema* was actually published in 1859, not 1860 (the imprint date).

p. 751—See footnote 5 for *Crassiseta*.

Clare, Stewart and Oscar E. Tauber. 1942. Circulation of Hemolymph in the Wings of the Cockroach. Annals, 35(1): 57–67:

p. 59. The figures A-E are exchanged with figures A-E on page 62. The legends are correctly placed on pages 59 and 62.

Kennedy, Clarence H. 1942. *Palaemnema lorena* and *P. melanocauda*, New Species, etc. Annals, 35(1): 97–104:

p. 100, line 4—Pacific should be Atlantic.

Hart, Thomas A., 1942. Larval Pilotaxy of *Culex pipiens* with Special Reference to Genetics. Annals, 35(2): 141–142:

p. 145, figures 1 and 2—In legends "dorsal view" should read dorsal and ventral views.

p. 146, figures 3 and 4—In legends "dorsal view" should read dorsal and ventral views.

Fairchild, G. B. 1942. Notes on Tabanidae from Panama, VIII, Annals 35(2): 183–199.

p. 196—*Esenbeckia illota meridionae* should be *Esenbeckia illota meridionale.*

DeLong, Dwight M. 1942. A New Genus (Plumerella) and a New Species of Grass Feeding Leafhopper from Mexico. Annals, 35(2): 200–202.

p. 200—Plumerella should be Plummerella.

Fairchild, G. B. 1942. Notes on Tabanidae from Panama. Annals, 1940–1942.

p. 472, Vol. 35, 1942—See "Addenda" for corrections and notes on the errors and omissions in the series of parts published in these Annals.

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